121

Transactions and Year Book

of [redacted]

The University of Toronto Engineering Society

April, 1921

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The Transactions

of the

University of Toronto Engineering Society

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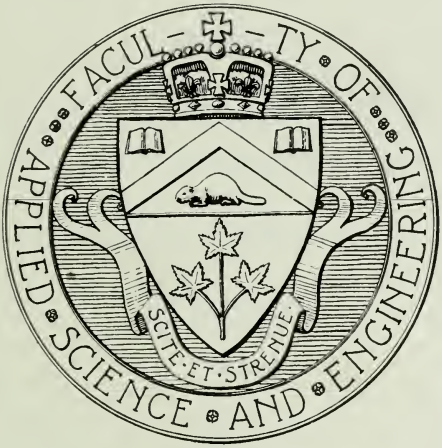

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1922/23

To

The Largest Class

that ever passed through

"The School of Science"

and to

Dean C. H. Mitchell

Honorary President of that Class

This Volume is Affectionately

Dedicated

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Foreword

ADDRESS OF THE RETIRING PRESIDENT

The publication of this book marks the close of the activities of the Engineering Society for another year. A review of them is unnecessary, for it is my hope that the entire book is exactly that.

On looking back over the year's work and the results of that work, one is struck with the conviction that the Engineering Society has grown to fulfil to a great degree the non-academic requirements of the students of this Faculty. To accomplish that completely will, I hope, be the motive directing the policies of future executives.

Centralization in the Engineering Society of all the activities of "School" men, has now been practically reached. Undoubtedly, this centralization is necessary for sound financial support and a successful business administration. However, this centralization should not be carried to an extreme in which the various organizations are hampered in developing along individual lines. Rather the reverse should be held and the existing organizations should be given a free hand to develop themselves, with constant observation by the Executive of the Society to detect lagging efforts or radical missteps. In this case, the Society should step in and give moral, financial and publicity support towards a rejuvenation of that organization's work. In this way only can the whole system be kept running at maximum efficiency.

The Executive of the Society should keep in view those general policies with respect to the non-academic needs of its members, and function towards their fulfillment.

Firstly, the be-all and end-all of its existence should be to foster and develop that tribal loyalty among its members which has come to be known as "School" spirit. School men have attained a high reputation for the sincerity of that "spirit" here in the University and outside. Not only should this tribal spirit be fostered because its reality alone makes possible the success of the multitudinous activities of the Society, but because it is a splendid thing to develop in young men. A capacity for loyalty and unselfish co-operation is an inestimable quality in the make up of any man, and a great factor towards his success and towards holding the respect of his fellows.

Secondly, the Society should endeavour to provide means for its members to become well acquainted. Undoubtedly one of the most valuable results of University education is the friends and acquaintances made. They not only make pleasant our four years stay here, but prove to be a great boon and pleasure in life after graduation. The Society has all

the machinery to accomplish this end and every effort should be made to draw out the hermit and inculcate a spirit of wide and real friendship among its members.

Thirdly, the Society should stand firmly and whole heartedly behind the efforts of the School Athletic Association, for on its activity, to a great degree, depends the status of the "School" in the competitive life of the University.

Fourthly, the Supply Department should be a means of saving money to the students. It should be a convenience and a real assistance by supplying the most requisite and helpful materials for their school work. It should be the community centre around which the life of the school revolves.

Fifthly, the Society should be the means of promoting a good understanding between the faculty and the students, for by a good understanding and complete exchange of views alone, can confidence be retained on both sides and the best obtained from the course. This year the formation of a Liaison Committee, which meets monthly, a committee composed of members of the Faculty in conference with the four year presidents and the president of the Engineering Society, has been a great step in this direction, and it is hoped that it will continue and grow in activity and importance.

Sixthly, the Society should endeavour to add to the regular course of the school as much non-academic education as possible. This can be best accomplished by the clubs themselves obtaining addresses from practical men engaged in their particular branch of engineering, and a few general meetings of the Engineering Society addressed by the best speakers procurable on subjects of general engineering interest.

Lastly, the Society should take its place in University activities and assist to the full extent of its resources, for only by the co-operation of the major faculty organizations can the success of University functions be assured.

In conclusion, the future executives of the Society would be well advised to observe that the program of the Society has changed considerably from year to year, and that its success to a great extent depends on its elasticity, for times are changing and people and students change with them.

I wish to thank the Dean and the Faculty for their support and advice, the executive and all members of the Society for the remarkable way they have supported me this year, and especially thank those few good souls who have been most closely connected with the work and have so generously given their time and best efforts to the work of the Society.

To my successor, Bill Osbourne, a successful year and a merry one.

F. J. Lyle.

THE TRANSACTIONS of the
University of Toronto
Engineering Society

WITH WHICH IS INCORPORATED THE "APPLIED SCIENCE"

No. 36 TORONTO, APRIL 15, 1923 1922-23

SOME LARGE ENGINEERING PROBLEMS AND THEIR SOLUTION*

By T. Kennard Thomson, S.P.S. '86.

There is probably no contractor in the country who has not had occasion to express his opinion of some young pile inspector in very strong language. For the old contractor knows that the pile has been driven as it ought to be driven in that location, while the young inspector insists that they are just at some thin crust and insists on the further pounding of the pile, when all of a sudden the pile drops six or eight feet. "There," exclaims the young man, "I told you, we have gone through the thin crust now, so keep on driving until you come to hard bottom." But what really happened is that the pile had simply been pounded to destruction. In the case of some oak piles driven at Columbus, Ohio, described in Engineering News, of January 14th, 1909, the engineer states that 38 per cent. of these oak piles were destroyed in the driving.

Wooden piles, concrete piles, open coffer dams, pneumatic caissons, all have their proper places, and should be used there. And as regards the pile, the engineer should know before he starts driving how far he should drive it, instead of judging by the amount of battering on top.

Vacuum Method

In 1852 an ingenious gentleman by the name of Potts attempted to put some six-foot diameter cylinders down 25 feet or so by the vacuum method, for he figured that if he pumped all the air out of the cylinders the weight of the atmosphere would amount to some 30 tons, and would be sufficient to drive these cylinders to the required depth. But, unfortunately for the inventor, logs were encountered, so his method would not work. The reverse was then tried, which was called the "Plenum Pneumatic" method. It was the first attempt to use compressed air for foundation work in America.

*From an address before the Society.

Caissons

The next case was at the Third Avenue Harlem River Bridge, New York City. In this case a French engineer was engaged at a very high "per diem" which he innocently thought would continue to the end of the job. But, unfortunately, after about one week the contractor, who thought he had learned all the Frenchman could tell him, laid him off. This bridge had all cylindrical caissons, each ten feet in diameter.

The next caisson job was the first big caisson work in America, used for the Eads Bridge, St. Louis, Mo., in 1869. It is a liberal education to read the history of that bridge, so I hope that you have it in your library. As you know, we now have many text books and formulas for designing bridges and caissons and so on, whereas Eads had to make his own formulas, design his own shapes, decide what kind of tension members to use, as eye-bars were practically unknown. So the bridge was really a marvelous achievement. He put his air lock down in the working chamber instead of putting it on top as we do now. He had an enormous amount of timber in his deck, 9 to 14 feet, compared with the 3 feet of the modern caisson. I have built many of these, but now we often leave out all the timber in using reinforced concrete.

Caissons for Building

The first building ever put on caisson foundation was in New York for the Manhattan Life Building in 1893. Here they built a steel caisson and tried building the brick work directly on top of it, but they soon found that the friction of the earth opened up the mortar joints of the brick work.

The contractor for this job though he had an economical method of procedure by blowing out the New York quicksand with more or less water and allowing it to flow into the sewers. But, unfortunately, the city officials were mean enough to object to having the sewers plugged and compelled him to clear the rest of the material away, a much more expensive method.

A pneumatic caisson in the process of sinking carries a lock on top of the working shaft with a top horizontal door and a lower flap door. The top door being open, the bucket drops into the lock and the two halves of the door close around a cable, then the valve is opened which permits the compressed air to flow into the lock. As soon as the air pressure in the lock is the same as that in the caisson below, the bottom or flap door drops of its own weight, after which it is a simple matter to lower the bucket into the working chamber and to attach a cable to another bucket which can be removed while the other bucket is being filled.

The air pressure must be just sufficient to balance the water pressure. As a cubic foot of water weighs 62 1/2 pounds, the weight at the bottom of the cubic foot is 62 1/2 which, divided by 144, gives .434 pounds per square inch, or a little less than half pound for each vertical foot of depth. That means that if the water is ten feet deep the pressure would be 4.34 pounds per square inch. For one hundred feet deep it means 43.4 pounds per square inch.

Deepest Caisson

The greatest pressure on record was for the Municipal Building in New York City, where we had a depth of 112 feet and a pressure of about 50 pounds. I have always noticed that the actual pressure in the air chamber was very close to the theoretical head, whether in the heart of the city or right in the river.

In the first caisson in the Municipal Building, the pressure being so much greater than the contractor had previously experienced, the air pipe broke, and although it was only fifteen minutes before the pipe had been mended and the air pressure put on again, it was found that in the fifteen minutes the working chamber had been filled with sand, the sand was 16 feet above the deck, and the water 42 feet up the shaft. By a streak of good luck, the workmen had started up the shaft when this accident occurred, and you may be sure that they climbed up that ladder as fast as they knew how. In spite of which the last man had his feet in the water until he got above the 42 feet from the bottom.

The cheapest method of all, where it can be used, is to have a 5-inch pipe with a flexible hose at the bottom, and an elbow at the top. By opening a valve in the working chamber the sand and gravel can be blown out through this pipe as fast as it can be shoveled up to the pipe. In this case the speed of the work depends more on the speed of adding the coffer dam and the weight above than on the excavation.

I have seen the windows of a tug two hundred feet away smashed by the pebbles blown out through this pipe, and it is necessary to use the hardest kind of material, generally manganese steel, for the elbow. I have seen a cast iron elbow two inches thick worn right through in an hour.

Build Up of Caissons

If the caissons are not more than 25 or 30 feet high, it is generally advisable to place all the concrete to this height before starting to sink. This makes a quick and economical job, and often prevents material from crowding in around the sides, greatly increasing the friction. In New York City I have carefully estimated the friction, and find it to vary from 30 to 650 pounds per square foot of a superficial exposed area.

Caisson Disease

No one should be allowed to enter a compressed air chamber without a thorough medical examination, and anyone with a bad cold or anything the matter with his heart or lungs should not attempt to enter. Much more attention is paid to this now than formerly.

The first sensation in the lock is plugging of the ears or nostrils, and if this is not relieved the ear drums or blood vessels in the forehead may be ruptured. As for the drums, one soon learns how to equalize the pressure on both sides of the drums either by swallowing, chewing or holding the nostrils and blowing so as to get the same pressure inside as outside of the drums.

The Bends

The next trouble is usually called the "bends," named because the

first man who experienced that trouble doubled up with pain which seemed very funny to the onlookers but not to the victim.

The bends might be described as sharp twinges like rheumatism or worse, and are generally due to entering the air chamber too quickly, allowing the air to displace the blood. They are also to a lesser extent due to coming out too quickly, from working too hard, or from working too long in the working chamber. In many places the law now specifies the time to be taken in entering and leaving, a law which has greatly reduced the amount of caisson sickness.

It has always seemed to me that foul atmosphere has more to do with this disease than even higher pressure. For when we sunk the caisson in the Harlem River, our men were a good deal troubled with caisson disease when going through the foul river mud, but after passing through the clean clay below at a very much higher pressure, they experienced very little trouble.

I have had the bends twice—quite enough—once in the arms and once in the leg. The first time I obtained relief by electric shocks, which did not do me any good the second time, but I found (that was long before the day of hospital locks) that by going in slowly, not staying in long, and coming out slowly, I was a little better after each trip, so I kept it up until I was free from pain. Nowadays, however, we have well-equipped hospital locks in which the patient can be put and carefully watched while under recompression.

One superintendent in one of the tunnels had a bad case of the bends and was yelling for his doctor to hurry up and put him in the lock, until the doctor lost patience and told him that he would have to wait until he got a dead man out of the lock. This same superintendent once told me that, as he was going into the office, one of his men stopped him and he asked him to wait a minute or two. In a few minutes, however, the man who had just come out of the caisson was found dead. The post mortem did not disclose the cause of the death. So, as the superintendent said, we have a whole lot to learn.

Caisson Paralysis

But far worse than the bends is paralysis, and after a person has been once paralyzed by compressed air, he has no business to try it again. I have seen many who thought they were immune, but sooner or later their very carelessness resulted in an exceptionally bad attack. When one sees a half-paralyzed watchman or lock tender on these jobs, it is quite evident what the cause of his trouble was. On rare occasions a man is killed outright in the caissons. Many caisson diseases are now cured by re-compression and de-compression in the hospital locks. These locks are required by law in many States.

Launching, etc.

There are many ways of getting a caisson in position for sinking. Small caissons may be hauled to the site and lowered in position by derricks. The river caissons are sometimes built on shore and skidded into

the water. Occasionally skids are not made strong enough and break down. Carelessness is expensive.

Pontoons

Another way is to build a caisson on a pontoon, which is nothing more than a flat-bottomed boat having a three-inch plank at the bottom and the sides, arranged with a five or six-foot space all around the caisson to permit the building and caulking.

These pontoons have one or more joints in the bottom and are so arranged that when the caisson has been built, perhaps 14 feet or more high, and is ready for sinking, the connecting bolts of the joints are taken out and sand or gravel for weight is placed in the working chamber near the centre of the pontoon. The water is then allowed to flow in until the caisson is floating, taking most of the weight off the pontoon. Then the two halves of the pontoon often shoot out from under the caisson in a few seconds, with the caisson floating like a boat.

A new superintendent who had watched over the launching without using his eyesight properly, tried to launch his first caisson, but let a small amount of water enter and freeze before putting in enough to sink the caisson and pontoon down together. The result was that it took him three weeks to get his caisson off the pontoon instead of a few minutes.

Sometimes tugs are used to pull the halves apart, sometimes blocks and tackle with struts operating near the centre of the pontoon.

Building on the Site

Out in the Missouri River the water was too shallow to float a caisson and carried too much sediment to make it possible to keep a channel dredged, so in that case we built a platform from which we hung the caisson up by means of sixteen three-inch rods, and after the caisson was ready for sinking, a gang of Italians turned the nuts at the tops of these rods, letting the caisson down gradually.

This looks like a clumsy method but, as a matter of fact, it turned out to be satisfactory and economical in this case, the time required being from twelve to twenty-four hours per caisson.

As an illustration of the trials and tribulations of a contractor, the case of a caisson in the Missouri River is pertinent. This caisson got badly out of plumb, in spite of the efforts to pile the weight on one side while undermining the cutting edge on the other side. The water rose so high that all efforts had to be abandoned for the time being, and finally when the water lowered a little the sand hogs were again put into the air chamber and succeeded in righting the caisson. Up to this time the contractor did not know whether the caisson was a total loss or not.

Niagara River Water Power

The possibilities of utilizing the Niagara Falls water power have, of course, been obvious ever since the Falls were first discovered. But until very recently it was thought by most that the power was so unlimited that there would never be any need of developing the full force for commercial purposes.

The Porter family for generations endeavored to utilize part of this power, in the first place by operating mills and discharging water at a slight distance below the top of the bluff as they had no machinery in those days for handling the full head.

About 1850 a foresighted pioneer, Horace H. Day, obtained rights for a hydraulic canal which he actually constructed, but, being in advance of his times, he lost a million dollars in the venture. Then, in 1870, when that shrewd Buffalo banker, Jacob Schoelkopf, bought this canal for $75,000, people laughed at him and intimated that the old man was in his dotage. Many of these scoffers, however, would be only too pleased if they had had the ability and foresight to buy that canal, now worth many millions. It gave Jacob's son and grandson an opportunity of developing the Niagara Falls water power on a large scale, which they still control.

Hon. Peter A. Porter, as Assemblyman and afterwards Congressman, introduced a bill for the first hydro-electric plant in Niagara in 1886. This resulted in the first hydro-electric power being delivered in 1895. Scoffers again declared that there would never be a use for 50,000 horse power whereas, now, single consumers take far greater amounts.

This first development was quickly followed by four others, until the five pioneer companies, who staked their money and courage on this untried venture, had developed some 650,000 horse power at a cost of $65,000,000 or $100 per horse power. Being hard-pressed, as is always the case with pioneers, they made some long-term contracts, and sold much of this power from $9 to $15 per horse power.

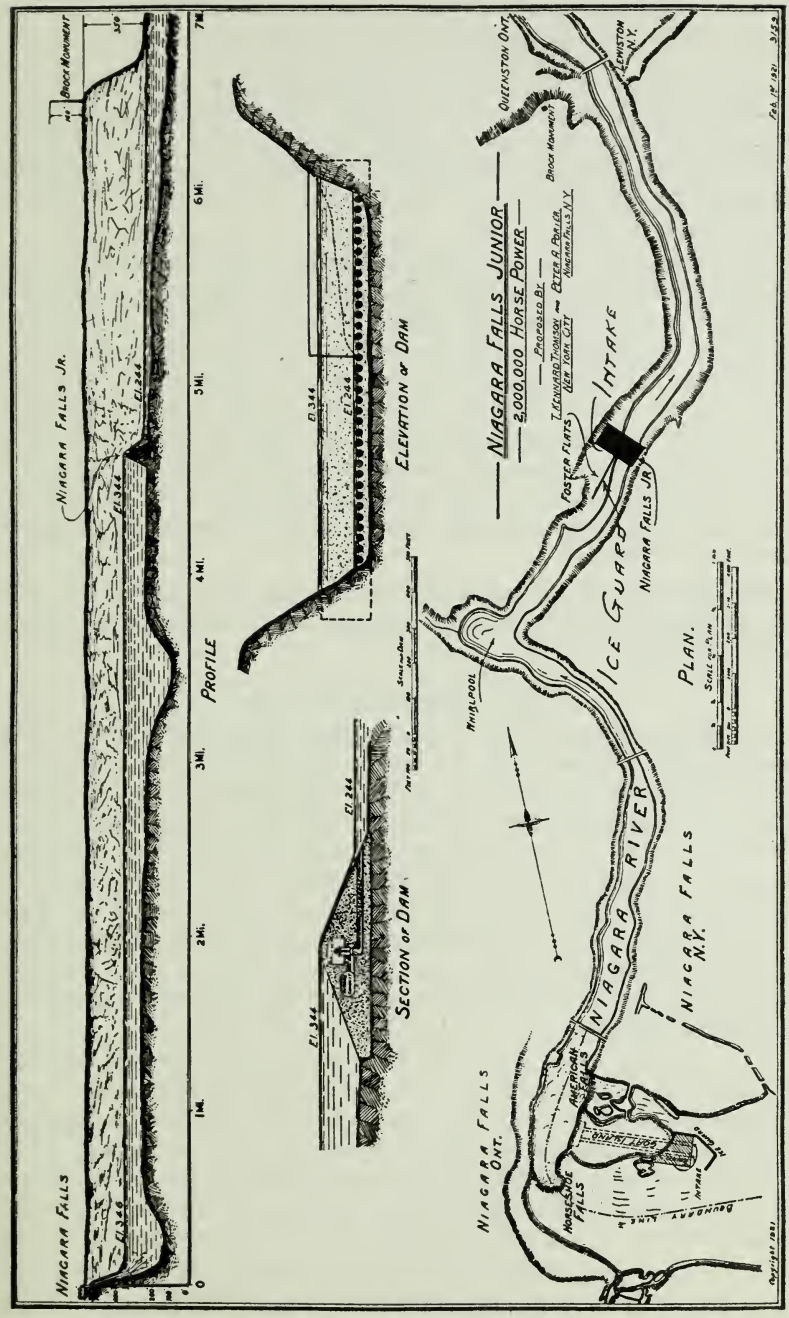
Effect on Industry

Incidentally, it may be remarked that the development of this water power had far-reaching results, probably never even contemplated by the promoters, and these results undoubtedly affect nearly every household in America without such households having the slightest suspicion of the fact. To take a single example, for instance, this cheap power made many things possible which were impossible before, such as cheap aluminum ware, the cost of which this power very greatly reduced, from $12 a pound to twenty cents a pound. So, surely, everyone who buys aluminum ware must now benefit by this great development, even if they do not know it.

This power also brought into existence, accidentally it is true, carborundum, which at first was sold for something like its actual value, but very quickly reduced in price to about the same extent as aluminum.

In addition to the $65,000,000 spent in the development of 650,000 horse power, the amount of investments in other industries, railroads, electric lights manufacturers and so on, resulting therefrom was $650,000,000, ten times the cost of the plants themselves.

In other words, the indirect value of hydro-electric power is easily ten, if not a hundred, times the direct value. For instance, the development of one hydro-electric horse power is supposed to make permanent work for one man. So if four million horse power were taken out of the Niagara River we would make permanent work for four million men. Utilizing


NIAGARA FALLS JR.
PROFILE
ELEVATION OF DAM
SECTION OF DAM
NIAGARA FALLS JUNIOR
2,000,000 HORSE POWER
PROPOSED BY
T. KENNARD THOMSON
PETER A. PORTER
NEW YORK CITY
NIAGARA FALLS, N.Y.
INTAKE
ICE GUARD
WHIRLPOOL
NIAGARA RIVER
NIAGARA FALLS
NIAGARA FALLS ONT.
NIAGARA FALLS N.Y.
HORSESHOE FALLS
BOUNDARY LINE
QUEENSTON ONT.
LEWISTON N.Y.
BROCK MONUMENT
PLAN.

the whole minimum flow of the lower Niagara River and half the flow of the upper river, there would still be left one half the water to go over the Niagara Falls, after the development of four million horse power.

The next step of the development of the river was when the Hydro-Electric Power Commission of the Ontario Government, which had been buying power from the pioneer companies at from $9 to $15 a horse power, decided to obtain more power. It adopted the policy of taking advantage of the fall in the lower river as well as the upper river, and started the Chippawa-Queenston Canal.

The Chippawa-Queenston Canal is twelve and three-quarter miles long and loses about sixteen feet of the head, due to the grade required for a canal of this length and cross section. It was designed for only 16,000 cubic feet per second, whereas the minimum flow of the river is from 200,000 to 220,000 cubic feet per second. In the present international agreement, the Ontario Hydro is not allowed to take enough water from above the Falls to operate its own plants, plus the new plant, so in order to pass 16,000 cubic feet of water per second through the Chippawa-Queenston Canal it will be necessary for Hydro to put one of their old plants out of commission in order to get the extra power, unless a greater diversion is sanctioned.

But if there were no other way of obtaining this extra power, even such expenditure would be justified, as power would still cost a fraction of the cost by coal.

Cost of Coal-generated Power

It might be mentioned here that when the first power project was being considered for Niagara, coal was being sold at $1.50 a ton, quite some difference from the present price, and when Mr. Stetson, the New York lawyer, was explaining the possibilities in London, they told him that it would never work because power generated by coal only cost one farthing per hour, a farthing, of course, being one-half cent. So Mr. Stetson at once figured out for them that one-half cent an hour amounted to $36 a year, and explained that he would be very glad to sell Niagara Falls power for $15 a horse power. As a matter of fact, he sold afterwards much at $9 to $15. Since that, the increased price of coal enormously increased the difference.

The cheapest power I know of developed by coal before the war was by New York Edison and New York Interborough, the average cost being about $32 a horse power. That means $70 to $80 horse power now. It should be remembered that these are high-grade plants, not average or poor ones. A year and a half ago it was testified in Washington that it has actually cost $100 a horse power at Niagara Falls, N. Y., to develop such power by coal. These prices are of course exceeded in Canada.

No matter what hydro-electric power is sold for, it will always be worth what it costs to develop it by coal, as there will never be enough

water power in the United States to do away with the use of coal, until at least we learn how to utilize the tides, either by storage batteries or otherwise.

Foster Flats Development

Coming back to the Niagara River, we claim that a dam four and one-half miles below the Falls will take care of the entire minimum flow of the lower river, or 220,000 cubic feet per second, and not cost any more than the Ontario government canal, which handles only 16,000 cubic feet per second.

Similar diversions have been sought after on the American side of the line, but obviously they will cost much more per horse power developed than the Canadian efforts, for the reason that the land is much more valuable in New York than in Ontario, and besides there is an enormous net-work of railroad crossings and highways, etc., which are always expensive items. Furthermore, the cost of labor and material has appreciably increased. On the New York side of the line, strenuous efforts are being made to obtain permission to build tunnels, taking the water from below the Falls, and returning it in the lower Niagara River. Advocates for this scheme acknowledge that they can only obtain 75 foot head out of the total 100, which means a permanent loss of that proportion of power.

Then these advocates do not dare ask that the diversion for both sides of the river should be allowed for more than one-half the flow of the river. So, obviously, if they have 75 per cent. head, and half the flow, they would only get thirty-seven one-half per cent. of the value of the lower river, for both sides of the river combined.

This also would be justifiable were there no way of obtaining the full value, but there certainly is. The real solution is to build a dam four and one-half miles below Niagara Falls, on the lower end of what is known as Foster Flats, a really ideal location for a dam and power plants. The location of such a dam is shown in Fig. 1.

This whole project, dam, power plants, transmission lines, interest on the money, etc., would cost less than one hundred million dollars, for two million horse power, as against three to five million dollars for 750,000 horse power, the maximum amount that can be obtained from all minor diversions. As there is a 102 foot drop in the Niagara River, and a minimum flow of 220,000 cubic feet per second, two million horse power can be obtained.

Most people are appalled, first of all, at the idea of a dam in the Niagara River, but I have pointed out to them what an easy matter it would be at this site. For while at many places, the Niagara River is from 150 to 190 feet or more in depth, at Foster Flats it is only about 35 feet. Foster Flats is the only place in the Niagara River where there is a gentle incline before the almost vertical bluffs.

It would be possible to build the first part of the dam on Foster Flats on the Canadian side of the river, on what is now dry land, having

the base of the dam some twenty or thirty feet below the bed of the river at that point, making it possible to leave openings in the bottom of this part of the dam to divert water from the present channel of the Niagara River. Then it will be a comparatively simple matter to build the second or last section of the dam in what is now the channel, 500 feet wide, of the Niagara River. The length of the dam will be about 1,500 feet. At present the water level on the site of the dam is some 25 feet above the Lewiston level, so it will, of course, be necessary to blast out some of the rocks below the dam in order to obtain the full hundred foot head.

Many people, even some of my opponents, have acknowledged that sooner or later this dam will have to be built, and as it will naturally be able to handle the entire flow, therefore any and all minor or partial diversions will simply be unnecessary after the completion of this dam. Why, therefore, saddle the ultimate consumer with a cost three to five times as high as necessary?

Goat Island Scheme

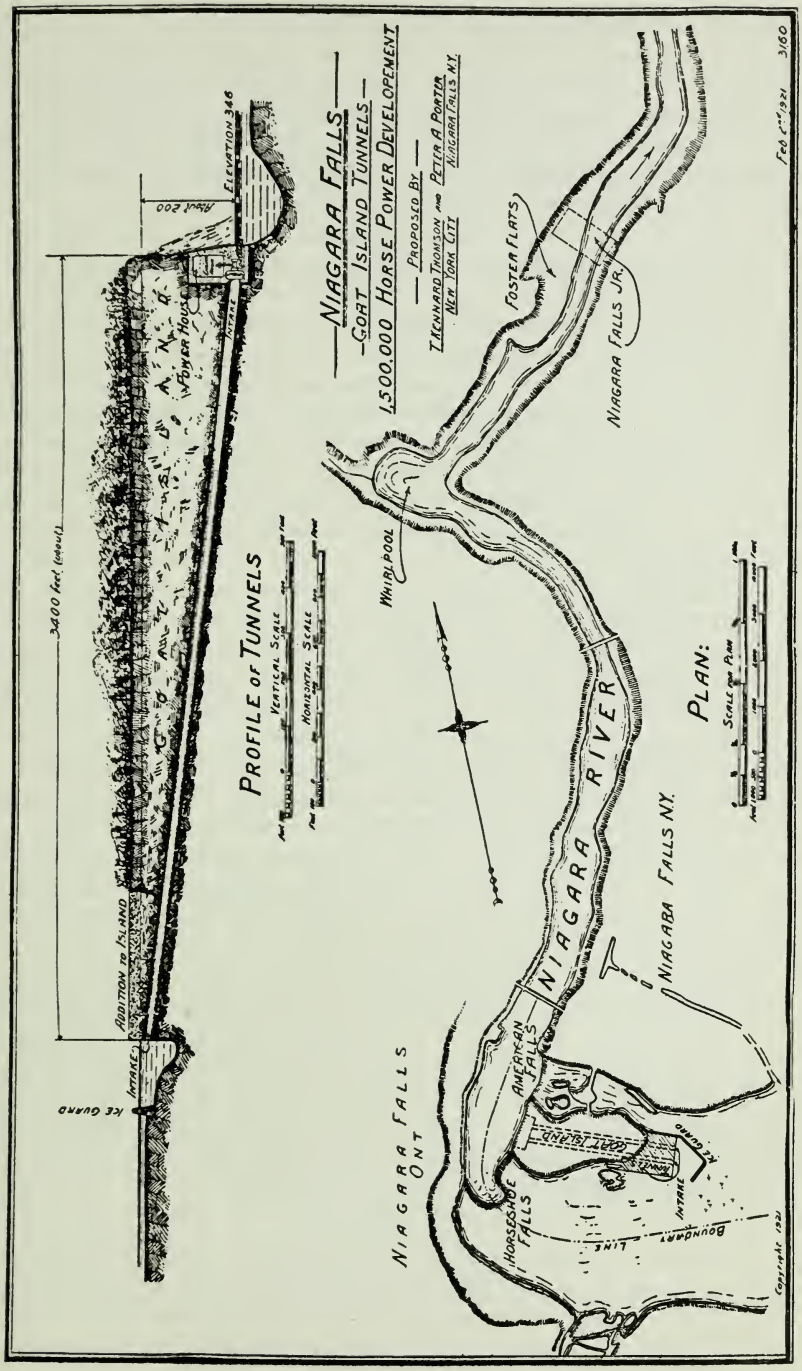
I might state here that while the dam will be absolutely the most economical method of developing the maximum amount of power at the minimum of cost, from the lower river, the method which will develop the maximum amount of power at the minimum of cost for any further diversions of water to be diverted from the Niagara River above the Falls, is our project for tunnels under Goat Island, shown in Fig. 2. By extending Goat Island we would increase its natural beauty for some thousand feet or more, and utilize the 60 foot drop immediately above the crest of the Falls.

It has been recommended that half the flow of the Niagara River be diverted from above the Falls, which if carried through our Goat Island tunnels, would give two million horse power, which added to our two million from the Lower Gorge, would make four million in all.

Many claim that half the flow of the river can be diverted without injuring the view of the Falls. It seems to us that the volume of water has a great deal to do with the marvellous beauty and that any diversion at all must have more or less effect on one of the grandest spectacles in the world. So we claim that our Niagara Falls Junior should be constructed, first, as it does not draw any water away from the Falls, nor the old power plants, and that after our two million horse power is used, and the public is clamoring for more power, then any further diversion from above the Falls which may be decided on should be carried through the shortest possible tunnels, as shown in our Goat Island project.

Surely is it not obvious that 3,500-foot inclined tunnels and a 1,500-foot dam are more economical than tunnels six to ten miles long, or canals twelve three-quarter miles long?

While we have shown the decidedly uneconomical projects which have been completed, or proposed, there is another vitally important point. We know that hydro-electric development attracts manufacturers and industries only on the assurance of cheap power and uninterrupted service,


NIAGARA FALLS
GOAT ISLAND TUNNELS
1,500,000 HORSE POWER DEVELOPEMENT
PROPOSED BY
T. LEONARD THOMSON AND PETER A. PORTER
NEW YORK CITY
NIAGARA FALLS N.Y.
FEB 2ND 1921
3/160
PROFILE OF TUNNELS
VERTICAL SCALE
HORIZONTAL SCALE
3400 feet (about)
ADDITION TO ISLAND
ICE GUARD
INTAKE
POWER HOUSE
ELEVATION 346
HIGH 200
WHIRLPOOL
FOSTER FLATS
NIAGARA FALLS JR.
NIAGARA RIVER
NIAGARA FALLS N.Y.
PLAN:
SCALE OF PLAN
NIAGARA FALLS ONT
AMERICAN FALLS
HORSESHOE FALLS
GOAT ISLAND
BOUNDARY LINE
COPYRIGHT 1921

and that anything that would seriously interfere with these advantages would have very serious results. To take the extreme for instance, if large manufacturing concerns which are working full blast, entirely operated by hydro-electric power, should, without a moment's notice have the entire power cut off, with no chance of having the damage repaired for a couple of years, the disaster would of course be appalling, and naturally the greater amount of power so lost, the greater the calamity.

Ice Jam Hazardous

Yet once more I claim that it might be justifiable to take such a risk, if there were no way of avoiding it. But there is. It should not need a great imagination to realize that if half the flow of the river were diverted from the rapids, where rocks are now near the surface almost all the way across the river, many of these rocks must necessarily be 15 to 20 feet above the water, and anybody who once witnessed the enormous volume of ice that goes down the Niagara River in the spring, must realize the great danger of a quickly forming ice jam, which might pile up a hundred or more feet in height. Even with such self-evident conditions as the above, an engineer must, if possible, be able to give proofs of such drastic assertions.

We know that some dozen years ago, when no water was being diverted from the rapids, an ice jam occurred, which lasted only eight hours, piling the ice 40 feet above the tracks of the Gorge Railroad, backing the water up to the base of the old Falls, and more or less damage was done to the existing plants, and when the ice jam broke, it absolutely carried everything away from the banks of the river below, to a height of at least 20 or 30 feet above the water's edge, docks, wharves, trees, shrubs, grass. While it has been claimed that the damage was not very great, the only reason that it was not greater was that there was nothing left to damage.

Again, some million of years ago, an ice jam diverted the whole Niagara River at right angles, thereby creating the whirlpool and causing the flow to cut a brand new channel out of bed rock. Undoubtedly there have been many other ice jams not recorded in history.

So, obviously, as a number of times the entire flow of the river has not been enough to carry the ice away, how in the name of reason can half the flow of the river be expected to accomplish the purpose! Therefore it seems that all minor diversions either by tunnel or canal will not only cost three to five times as much, but will be almost sure to result in these diversions, causing financial suicide by destroying every plant in the river. Why go to such unnecessary expense with the danger of destruction so great, when another plan will be safe and economical.

Foster Flats Dam

The way to handle ice safely is to have deep water and plenty of current, and one of the modern methods of obtaining this is by submerged weirs. Our dam is a submerged weir. By building the first half of the dam high above the water with ice guards confining the ice to a channel

directly over the old channel and leaving a fore-bay directly over Foster Flats for an ample intake, we will have a minimum depth of water above our dam of over one hundred feet.

An ordinary dam of this height would have a base of possibly 80 to 90 feet to withstand the pressure, but we want to make our dam 700 feet wide at the base, which will not only give us excessive strength, but will also give us such a flat slope on the up-stream side that no ice can ever be retained, and with such a flat slope on the down-stream side that the ice will have no sudden drop to undermine the foundations, but will have a gradual slide down to deep water.

As we do not anticipate the minimum flow of water when the ice is flowing, there will probably be enough water to carry the ice over our dam, but if at any time this is not so, it will be a very simple matter to shut down one or two of the turbines for the time being, for a few hours, or even if it amounted to a couple of weeks, it would not be very serious.

In this connection, however, we expect to take care of the shortage by auxiliary coal plants. As a matter of fact, the full value of water power will never be obtained without the aid of auxiliary coal plants, for as we all know, uniform power must be supplied to manufacturers and others, and the maximum amount required for peak-load occurs for about half an hour or one hour a day only, so without the aid of auxiliary plants, a large amount of power must be wasted from 20 to 23 hours a day. One of the biggest problems the engineer and business man has to solve is how to use this power continually.

St. Lawrence River Project

The first step in canalizing the St. Lawrence River should be our project of building a dam in the Lachine Rapids, dredging the channel from this dam down to the City of Montreal, thereby reclaiming ten square miles of land from the river, and creating a million and a half horse power. This proposal is indicated in Fig. 3.

Montreal is now 24 feet above sea-level, without the necessity of any locks below Montreal. Locks in our dam would permit ocean-going vessels to reach Lake St. Louis level about 74 feet above the tide level and three or four such projects would enable boats to reach Lake Ontario, via the Welland Canal, Lake Erie.

The late Sir William Van Horne stated that my Lachine project would make Montreal one of the greatest ports in the world. Eight million horse power could be obtained from the Niagara and St. Lawrence Rivers.

If this work were done under government ownership, God help the countries! But if this is done on strict business principles with proper government regulations, the entire continent will experience a boom, lasting as no boom has ever lasted in the past.

Manhattan Extension

The addition of six square miles to the City of Manhattan may seem a far cry from Canada, but as a matter of fact the entire continent of North America is like a human system, a small sore on the smallest finger or toe being enough to upset the whole system, whereas anything which

benefits the health, wealth and happiness of any part must more or less benefit the entire continent. How much more, therefore, will the construction of a five billion dollar city on six square miles of the most valuable real estate in the world benefit us all?

The reason for this is that everything grown, mined or manufactured in North America as well as many parts of the world, will have to speed up production to supply the demand for this great city.

The only thing that I am afraid of is that when we actually start work with the usual American and Canadian rush and hurry, we will overlook many thousands of details which will make this city surpass in each and every detail, anything which has been attempted before.

There is probably scarcely a man or woman on the continent who could not, if they would, suggest one or more of such improvements, so that everything from the watertight cellar floor to the roof garden, would show the benefit of their help.

In fact the world should be combed for intellects of every branch of industry, not only engineering and architecture, but also in business, education, legislature, administration, banking, manufacture, social service, that is, every calling which goes to make up the work of a great city, should see to it that its particular requirements are properly taken care of, taking advantage of everything that has been done in past centuries and then making further improvements.

Features of Manhattan Extension

Just to give your own imagination something to start on, we never expect to burn a pound of coal, nor a cubic foot of gas, nor have a horse on the streets.

We never expect to bury a pipe or wire in the ground, but have one street devoted entirely for these utilities, so that all that will be necessary will be to open the cellar door to make the mechanical connection.

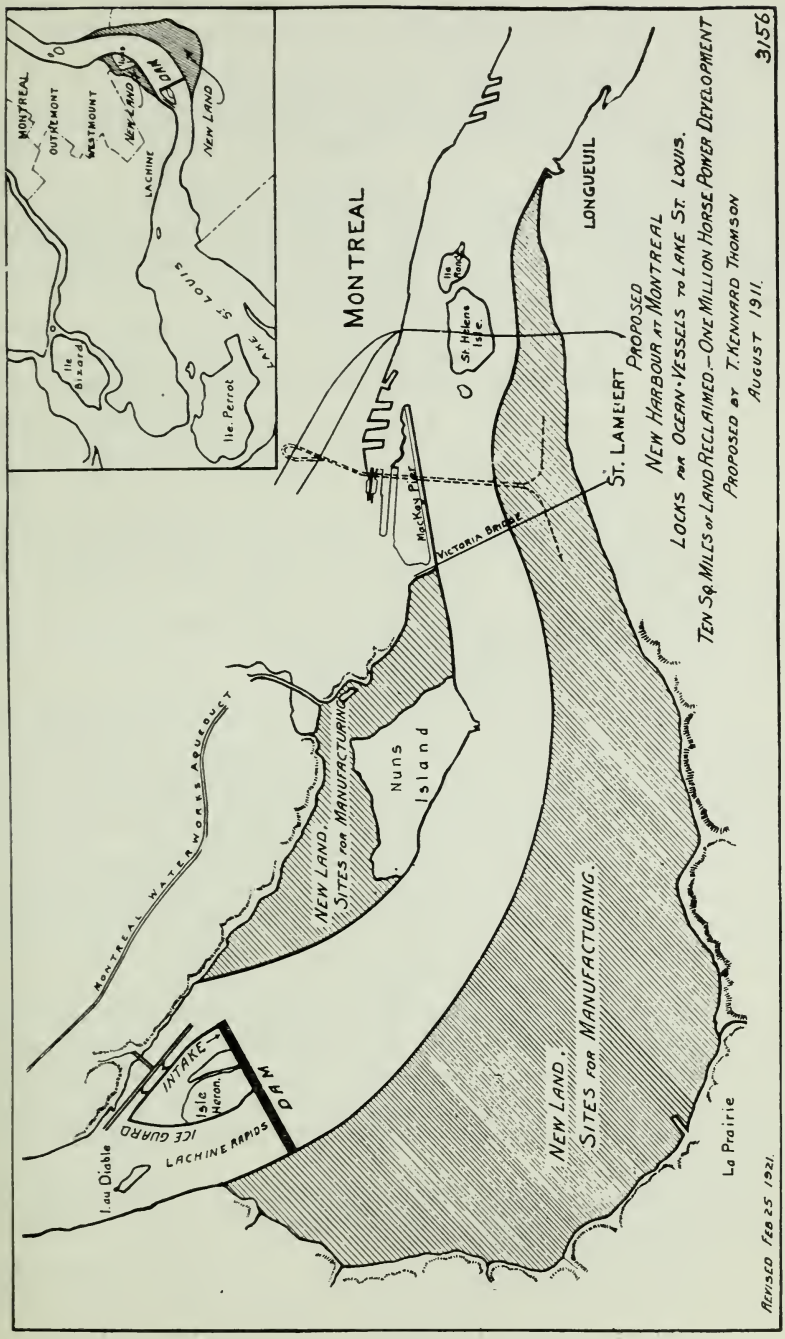
Above this we expect to have three street levels, not dark holes in the ground, but with sidewalks and stores on each side of them, as well lighted, heated and ventilated as the best department stores. The first street level above the pipe level will be for heavy trucking, with railroad tracks around the water front. The next level will be for rapid transit, and the top level will be for light traffic, automobiles, buses and so on.

Every building should cover a whole block and have a roof garden on top of it, with swimming pools where the young children could learn to swim.

The proposed plan calls for six square miles to be reclaimed from New York Bay, and added to the City of Manhattan.

This extension will be done section by section as fast as the land is needed for the buildings. For the first section or two we can probably build outside cofferdams to bed rock, permitting us to pump out the material in between, giving us several square miles of new land without any earth on top of the rock.

Down towards Staten Island where the rock is at greater depth, it may be possible to back fill by pumping sand from the ocean. If we have


MONTREAL
OUTREMONT
WESTMOUNT
NEW LAND
LACHINE
DAM
NEW LAND
LAKE ST LOUIS
Ile Bizard
Ile Perrot
MONTREAL
St. Helens Isle
Ile Ronde
LONGUEUIL
ST. LAMBERT
PROPOSED
NEW HARBOUR AT MONTREAL
LOCKS FOR OCEAN-VESSELS TO LAKE ST. LOUIS.
TEN SQ. MILES OF LAND RECLAIMED.—ONE MILLION HORSE POWER DEVELOPMENT
PROPOSED BY T. KENNARD THOMSON
AUGUST 1911.
3/56
MACKAY PARK
VICTORIA BRIDGE
NEW LAND.
SITES FOR MANUFACTURING.
Nuns Island
MONTREAL WATERWORKS AQUEDUCT
INTAKE
Isle Heron.
DAM
ICE GUARD
LACHINE RAPIDS
I. au Diable
NEW LAND.
SITES FOR MANUFACTURING.
La Prairie
REVISED FEB 25 1921.

to do this, I have plans in my office of one of the greatest dredge experts, of section dredges 40 inches in diameter, such as have been operating in Egypt for years, pumping 50,000 cubic yards of sand a day.

Fifth Avenue and 42d Street Crossing

One of the most congested crossings in the world is at Fifth Avenue and 42d Street, where the delay, if added up per vehicle or person per year, would be a simply appaling waste of time and money.

At this point 42d Street is ten feet higher at Fifth Avenue than at Madison Avenue and Sixth Avenue, so that if we were to reverse the grade and lower 42d Street fifteen feet at the Fifth Avenue crossing, the grade would be only one half of what it is now.

I have therefore proposed that the level of Fifth Avenue be kept as it is, and 42d Street run under it, turning the present cellars into the ground floors. I have made modifications of this plan to suit the views of the Fifth Avenue Association, which would keep the sidewalks and part of 42d Street the same level as it is now at the present, only lowering the centre so that the automobiles and trolley cars can pass under Fifth Avenue as well as foot passengers.

This means that automobiles and carriages can turn off Fifth Avenue on to 42d Street or vice versa, but can not cross Fifth Avenue on the present grade.

This improvement, in addition to the perpetual saving of time would save many people from missing their trains.

North River Tunnel

My proposed tunnel for a place like the North River was fully described in the Transactions of the American Society of Civil Engineers, 1920, pages 468-73. In this case I proposed driving rows of piles, building the tunnel like heavy concrete boat, say 170 or 180 feet wide and 500 feet long, which should be sunk on top of the piles after the silt had been pumped out. The joints should be made by sinking pneumatic caissons over the two sections already down, or by attaching pneumatic caissons to each section following the first, so that they simply telescope the preceding section.

Two Proposed Niagara River Bridges

In conclusion I wish to speak of two bridges which I want to build over the Niagara River, to show what we think of the boys who went "Over There." The three requirements for such structures should be beauty, strength and permanence. It has always seemed to me that the boundary line between Canada and the United States is the proper place for such structures.

The bridge at Niagara Falls should have a clear span of not less than 840 feet, and should be a massive steel structure, encased in concrete, with a hundred-foot roadway above.

The bridge between Fort Erie and Buffalo should have six main spans of 300 feet in the clear, each with a clear height of 90 feet above water, which the marine interests of the lakes have stated would be satisfactory.

ALLOYS OF IRON AND CARBON

By O. W. Ellis, M.Sc.

As early as 1890 it had been discovered that iron was a polymorphous element and during the past thirty odd years the transformations of this remarkable metal have been the subject of almost ceaseless investigation.

It has been definitely established that on cooling pure iron from 1,530°C (its freezing point) three distinct evolutions of heat ensue—one at 1,400°C., one at 898°C., and one at 768°C. These evolutions of heat are referred to as critical changes in so far as the first two are concerned and as critical range in so far as the last is concerned.

For convenience these transformations are denoted by the symbols Ar4, Ar3 and Ar2 respectively — A = arrest (arrète), r = refroiddisement (cooling), Ar — arrest on cooling.

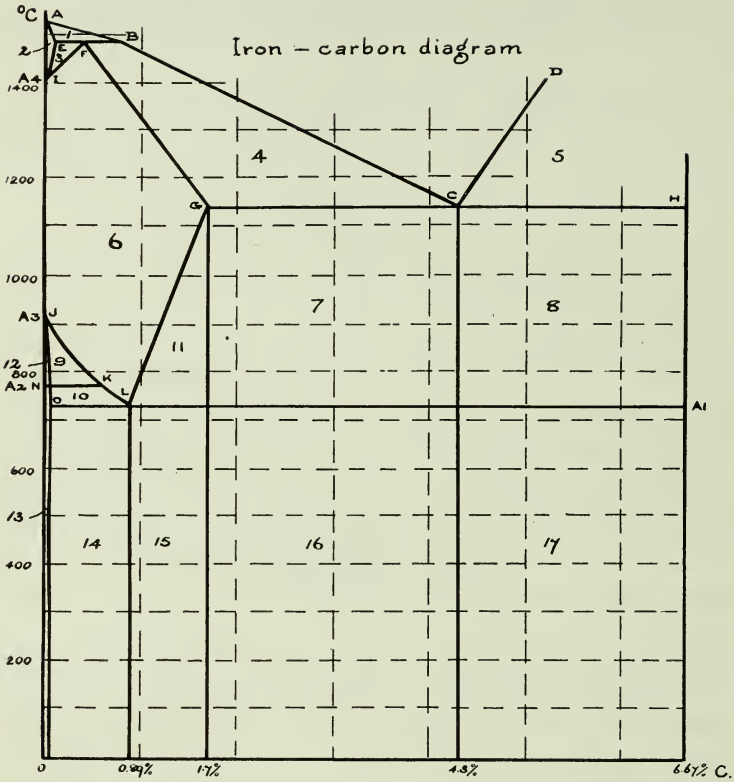
On heating pure iron these transformations occur with absorption of heat at 768°C, at 909°C and at 1,410°C; they are designated Ac2, Ac3 and Ac4 respectively—Ac=arrest on heating (chauffant).

When reference is made to these arrests, but it is not stipulated whether the same occur on heating or on cooling, they are designated A2, A3 or A4, as the case may be. It is convenient to assume that the A2 point occurs at 768°C, the A3 point at 903.5°C and the A4 point at 1,405°C —that is, that under conditions of equilibrium the arrests occur at transformations which are the mean of those at which they occur on heating or on cooling.

Above the A4 point iron is said to exist in the delta state, between the A4 and the A3 points in the gamma state, between the A3 and the A2 points in the beta state and below the A2 point in the alpha state.

To the phenomenon of the existence of an elementary substance in different crystalline state the term allotropy is applied. It having been shown that the alpha, gamma and delta state of iron are characterized by differences in crystalline arrangement, iron is said to exist in at least three allotropic forms. The existence of beta iron as a definite allotrope is disputed, owing to the fact that the change at A2 is associated, not with any crystallographic readjustment, but with a change in the magnetism of the metal. Iron commences to change from the ferro-magnetic to the para-magnetic state at relatively low temperatures. At A2 its rate of change of magnetism is at a maximum. Its magnetism reaches a minimum at 790°C.

Liquid iron is able to retain only a small percentage of carbon in solution. The limits of liquid solubility of carbon in iron have not been accurately determined.



Constitution Diagram

PHASES PRESENT IN AREAS OF DIAGRAM

Phase Area Phases

1. Liquid plus Solid solution of Carbon in Delta Iron.
2. Solid solution of Carbon in Delta Iron.
3. Solid solution of Carbon in Gamma Iron (Austenite) and Delta Iron.
4. Liquid plus Solid solution of Carbon in Gamma Iron (Austenite).
5. Liquid plus Cementite.

6. Solid solution of Carbon in Gamma Iron (Austenite).
7. Solid solution of Carbon in Gamma Iron plus Cementite plus Eutectic (Ledeburite).
8. Cementite plus Eutectic.
9. Solid solution of Carbon in Beta Iron (Beta Ferrite) Delta Iron (Austenite).
10. Solid solutions of Carbon in Alpha Iron (Alpha Ferrite) and Delta Iron.
11. Solid solution of Carbon in Gamma Iron plus Cementite.
12. Solid solution of Carbon in Beta Iron (Beta Ferrite).
13. Solid solution of Carbon in Alpha Iron (Alpha Ferrite).
14. Solid solution of Carbon in Alpha Iron (Alpha Ferrite) plus Pearlite.
15. Pearlite plus Cementite.
16. Pearlite plus Cementite plus Eutectic (Ledeburite).
17. Cementite plus Eutectic (Ledeburite).

Iron and carbon may combine to form a metastable compound, iron carbide, Fe_3C, which, under certain conditions, is subject to dissociation

$$Fe_3C = 3Fe + C.$$

This process of dissociation is referred to as graphitization, the carbon resulting from the decomposition of iron carbide being in the form of graphite.

To this carbide the name cementite is generally applied.

Iron and cementite form a metastable system of alloys. The system is metastable on account of the metastability of cementite. The constitution diagram of the system is shown on page 24.

In this diagram the lines AB, BC and CD represent the temperatures at which the alloys of this system commence to freeze. It will be noted that depression of the freezing-point of iron ensues as a result of the addition of carbon to iron. The components of the system—iron and cementite—form an eutectic containing 4.3 per cent. of carbon. The freezing point of the eutectic, to which the name ledeburite is frequently applied, is 1,135°C.

The lines AE, EF, FG, and GH (the eutectic horizontal) indicate temperatures at which these alloys become completely solid.

The addition of carbon to iron elevates the A4 point. This is indicated by the line IE, the slope and position of which make clear the fact that addition of 0.07 per cent. of carbon raises the A4 point to 1,486°C. This percentage of carbon is also the maximum amount of carbon that delta-iron is able to hold in solution.

The solubility of carbon in gamma-iron is indicated by the line GL, the slope and position of which make clear the fact that gamma-iron can retain as much as 1.7 per cent. of carbon in solution at 1135°C, but only as much as 0.89 per cent. in solution at 720°C.

The diagram also shows that the A3 point of iron is reduced as a result of the presence of carbon. The line JKL indicates the manner in which the depression of A3 proceeds with addition of carbon. It will be seen that the addition of 0.89 per cent. of carbon to iron results in the lowering of A3 to 720°C.

Both beta-iron and alpha-iron are practically unable to hold carbon in solution. Alpha-iron, for example, will retain only about 0.03 per cent. of carbon in solution at 20°C. The solubility of carbon in iron at 720°C is little, if any, greater than it is at 20°C.

From the above it will be seen that the 0.89 per cent. alloy is unique in that it is the alloy possessed (i) of the lowest A3 point (720°C) and (ii) of the maximum amount of carbon that gamma-iron is able to dissolve at 720°C. Now, since the gamma-iron of the 0.89 per cent. alloy is subject to transformation into alpha-iron at 720°C and, since carbon is practically insoluble in alpha-iron at 720°C, alpha-iron and carbon, in the form of cementite, are, when this alloy is slowly cooled, precipitated contiguously in the characteristic manner shown in Fig. 7. This structure is referred to as pearlite.

The solid solution of carbon in gamma-iron is referred to as austenite. That of carbon in beta-iron is referred to as beta ferrite, that of carbon in alpha-iron is referred to as alpha ferrite. Pearlite consists of alpha ferrite and cementite.

To recapitulate—at temperatures above 720°C the solid 0.89 per cent. carbon-iron alloy consists of austenite. On cooling the alloy slowly and uniformly, no radical change occurs in its structure until 720°C is reached. At this temperature the gamma-iron changes into alpha-iron and on this account carbon is thrown out of solution in the form of cementite. The products of dissolution, of the austenite—alpha-ferrite and cementite—arrange themselves in the characteristic manner of Fig. 7, a structure to which the name pearlite is applied. The 0.89 per cent. alloy is a eutectoid alloy.

Alloys of iron and carbon which consist entirely of austenite at any stage of their cooling from the liquid state are conveniently referred to as steels. The steels are, then, those alloys of iron and carbon that contain less than 1.7 per cent. of carbon. Commercial steels, however, rarely contain more than 1.4 per cent. of carbon.

Steels containing less than 0.89 per cent. of carbon are referred to as hypo-eutectoid steels, while steels containing upwards of 0.89 per cent. of carbon are referred to as hyper-eutectoid steels.

At temperatures above those represented by the lines JKL and LG the steels consist of austenite. The hypo-eutectoid steels on being cooled slowly and uniformly form temperatures above JKL are subject to structural change when they reach the temperatures represented by the line JKL. Those steels containing less than about 0.58 per cent of carbon undergo transformation at temperatures represented by the line JK. At these temperatures gamma-iron changes into beta-iron and since carbon is practically insoluble in beta-iron the austenite becomes enriched in carbon. As the temperatures of these alloys are depressed, further transformation of gamma-iron to beta-iron ensues, until the temperature 768°C (NK) is reached. At this temperature the precipitated beta-iron changes the alpha-iron. This transformation results in no change in the carbon content of the austenite, which, however, becomes enriched in carbon as a result of further fall in temperature and consequent transformation of gamma-iron to alpha-iron. By the time the temperature of the steel has reached 720°C the enriched austenite contains 0.89 per cent. of carbon—it is of the eutectoid composition—and at this temperature it changes into pearlite. These steels at temperatures below 720°C undergo no further change that need be considered here. They consist of alpha-ferrite and of pearlite in varying proportions.

Those steels containing from about 0.58 to 0.89 per cent. of carbon undergo transformation at temperatures represented by the line KL. The gamma-beta and gamma-alpha transformations being merged in the case of these steels, it may be said that at these temperatures the gamma-iron changes to alpha-iron and as a result the austenite becomes enriched in carbon. Slow and uniform fall of temperature is accompanied by further transformation of iron and further enrichment of the austenite, which by the time 720°C is reached is of the eutectoid composition and changes into pearlite. These steels, being subject to no change below 720°C, also consist of alpha-ferrite and of pearlite in varying proportions.

The 0.03 per cent. carbon steel consists entirely of alpha-ferrite, the 0.89 per cent. carbon steel consists entirely of pearlite. The structural composition of any hypo-eutectoid steel may be determined quite readily given this information. The 0.60 per cent. steel, for example, would consist of

$$\frac{0.89 - 0.60}{0.89 - 0.03} \times 100 = 33.8 \text{ per cent. of alpha-ferrite.}$$

$$\frac{0.60 - 0.03}{0.89 - 0.03} \times 100 = 66.3 \text{ per cent. of pearlite.}$$

The structure of this steel (as cast) is shown in Fig. 3. The proportions of the microconstituents in these steels as cast, differs slightly from those in these steels as slowly cooled. The proportion of pearlite is somewhat greater. This is occasioned by the relatively rapid cooling to which cast steel is subject.

The hyper-eutectoid steels consist of austenite at temperatures above those represented by the line LG, at which temperatures the steels become supersaturated in respect of carbon. On slowly cooling these steels, carbon in the form of cementite separates from the austenite at the temperatures represented by the line LG, and, in consequence, impoverishment of the austenite in carbon ensues. As the steels are cooled further separation of cementite supervenes until, when the steels have attained the temperature 720°C, the austenite is of the eutectoid composition and undergoes transformation into pearlite on account of the gamma-alpha change.

The hyper-eutectoid steels, being subject to no change below 720°C, consist at ordinary temperatures of varying proportions of cementite and pearlite.

The 6.67 per cent. carbon iron alloy (cementite) consists entirely of cementite, the 0.89 per cent. steel consists entirely of pearlite. The structural composition of any hyper-eutectoid steel may be determined quite readily given this information. The 1.15 per cent. steel, for example, would consist of

$$\frac{6.67 - 1.15}{6.67 - 0.89} \times 100 = 95.5 \text{ per cent. of pearlite.}$$

$$\frac{1.15 - 0.89}{6.67 - 0.89} \times 100 = 4.5 \text{ per cent. of cementite.}$$

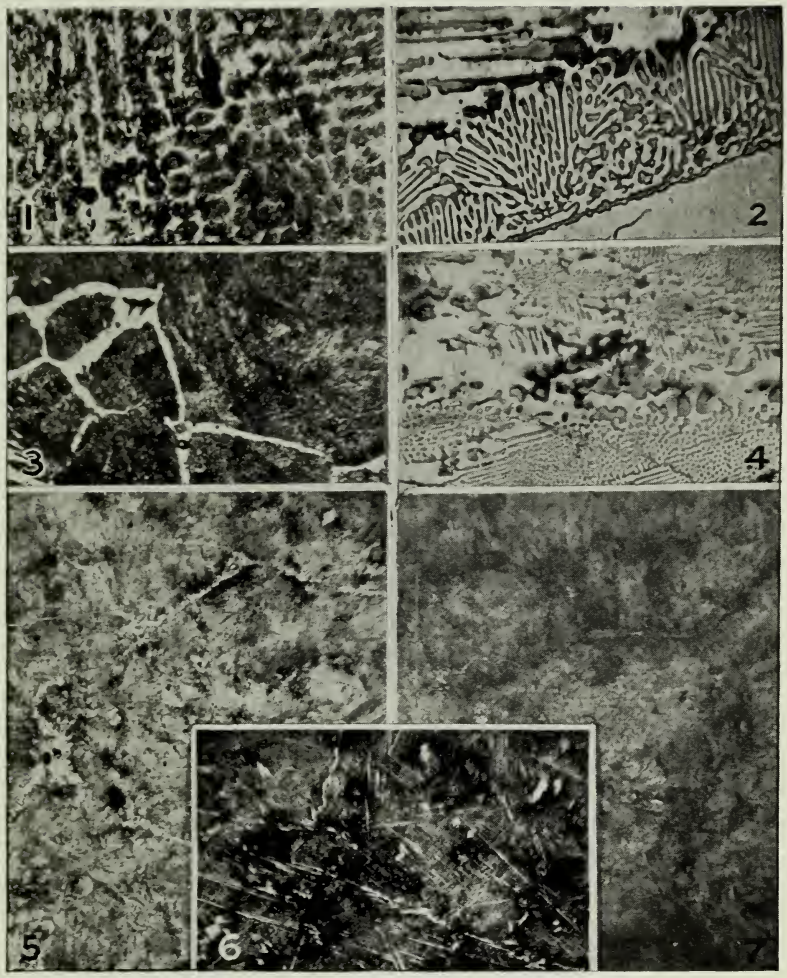
The structure of this steel (as cast) is shown in Fig. 5.

The 1.7 per cent. alloy, it will be noted consists at ordinary temperatures of the products of dissolution of 1.7 per cent. austenite—

$$\frac{6.67 - 1.7}{6.67 - 0.89} \times 100 = 86.5 \text{ per cent. of pearlite and}$$

$$\frac{1.17 - 0.89}{6.67 - 0.89} \times 100 = 13.5 \text{ per cent. of cementite.}$$

This alloy is of special importance in that at 1135°C 1.7 per cent. austenite is a constituent of *all* the alloys of carbon and iron containing more than 1.7 per cent. of carbon. The structure of this alloy is shown in Fig. 6.



Magnification 100.

Photo-micrographs of Various Steels.

At all temperatures above 1135°C the 4.3 per cent carbon-iron alloy is liquid. At 1135°C iron becomes supersaturated with respect to carbon and from the liquid carbon in the form of cementite is precipitated. The liquid on this account is momentarily enriched in iron. Now, since all the alloys of carbon and iron containing less than 4.3 per cent. of carbon freeze at temperatures above 1135°C and since gamma-iron is able to retain as much as 1.7 per cent. iron in solution (solid) at 1135°C, precipitation of austenite ensues. The alloy on this account is momentarily enriched (supersaturated) in carbon. Hence, further precipitation of cementite ensues. This is followed by further deposition of austenite, and so on. This alternate precipitation of the constituents, austenite and cementite at 1135°C, results in the formation of a solid of characteristic structure. The structure—ledeburite—is shown in Fig. 4. In this photograph the white areas represent cementite, the dark areas the products of dissolution of the 1.7 per cent. austenite, 86.5 per cent. of pearlite and 13.5 per cent. of cementite. It is, however, impossible to distinguish at the magnification of this photograph the constituents that have resulted from the dissolution of the austenite.

The alloys containing less than 4.3 per cent. of carbon other than the steels, are referred to as hypo-eutectic alloys. They may be considered white cast irons. Commercial cast iron, however, rarely contains less than about 2.5 per cent. or more than about 4 per cent. of carbon.

The alloys containing more than 4.3 per cent. of carbon, are referred to as hyper-eutectic alloys.

Freezing of the hypo-eutectic alloys commences at the temperatures represented by the line BC. It is complete at 1135°C, at which temperature 1.7 per cent. austenite and ledeburite are in equilibrium. At 1135°C the 1.7 per cent. alloy consists entirely of austenite and the 4.3 per cent. alloy entirely of ledeburite. The structural composition of any hyper-eutectic alloy may be determined quite readily from this information. The 3.0 per cent. white cast iron, for example, would consist of

$$\frac{4.3 - 3.0}{4.3 - 1.7} \times 100 = 50 \text{ per cent. of the products of dissolution}$$

of 1.7 per cent. austenite.

$$\frac{3.0 - 1.7}{4.3 - 1.7} \times 100 = 50 \text{ per cent. of ledeburite.}$$

The structure of this alloy is shown in Fig. 1. While not true in the strictest sense it may be said that the white areas represent the lede-

burite and the dark areas the products of dissolution of 1.7 per cent. austenite, to wit 86.5 per cent. of pearlite and 13.5 per cent. of cementite.

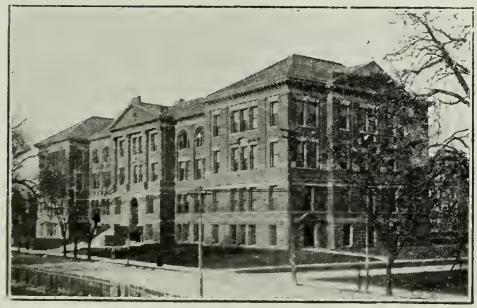
The hyper-eutectic alloys become supersaturated in respect of carbon at temperatures represented by the line CD. At these temperatures cementite is precipitated. The carbide continues to separate out of the liquid solution until when the alloy is at a temperature of 1135°C the liquid has attained to the eutectic composition. At 1135°C freezing of the alloy is completed and since, apart from the change which occurs in the 1.7 per cent. austenite of the ledeburite, no change ensues on further cooling of the alloy, these hyper-eutectic alloys consist at ordinary temperatures of cementite and ledeburite.

Give that the 4.3 per cent. alloy consists entirely of ledeburite and the 6.67 per cent. alloy entirely of cementite it is possible to estimate the structural composition of any hyper-eutectic alloy. For example, the 5 per cent. alloy would consist of

$$\frac{6.67 - 5}{6.67 - 4.3} \times 100 = 70.5 \text{ per cent. of ledeburite.}$$

$$\frac{5 - 4.3}{6.67 - 4.3} \times 100 = 29.5 \text{ per cent. of cementite.}$$

The structure of a hyper-eutectic cast iron is shown in Fig. 2.



WITH THE ROYAL ENGINEERS IN PALESTINE

By J. Roy Cockburn, M.C., B.A.Sc., M.E.I.C.

A brief summary of the work of the Engineers in the Egyptian Expeditionary Force during the Great War.

The Palestine campaign, although noted chiefly for the brilliant work of the mounted troops, was nevertheless one of the best examples in history of the employment and co-operation of all arms of the service.

It is the object here to outline briefly the work of one particular branch—the Engineers.

After the second unsuccessful attempt of the Turks in 1915 to invade Egypt and cross the Suez Canal, the British force, known as the Egyptian Expeditionary Force, drove him back across the Sinai Desert and then deployed on a broad front extending from the sea coast at Gaza along the edge of the "Promised Land" to the vicinity of Beersheba.

In the autumn of 1917, after the third battle of Gaza, the British drove the enemy back another sixty miles in the space of nine weeks. This advance was made in all kinds of weather, varying from a sand storm on the desert, to a snow storm in the Judean Hills, and eventually in the autumn of 1918 the Egyptian Expeditionary Force succeeded in the total destruction of the VII and VIII Turkish armies and the liberation of Palestine and Syria from Turkish rule. It is evident that such an army would make great demands upon its engineers.

The Desert Railway and Water Supply

The problem of transportation and water supply along the lines of communication extending from the Suez Canal to the front line was solved by building a standard gauge double-track railway from the base at "Kantara" across the desert and laying a pipe line alongside. This railway was eventually extended to "Haifa," on the Bay of Acre. The track was laid across the desert at the rate of one mile per day and part of the branch running to Beersheba was laid at twice that rate.

The old metre gauge railway running to Jerusalem was torn up and replaced by one of standard gauge which was incorporated in the general system.

During the war the railway was operated by the Royal Engineers, but after the cessation of hostilities it was taken over and operated by the Egyptian State Railway.

Previous to the III Battle of Gaza the main line of the "Kantara Military Railway" as it was called, had been laid as far as Dier el Belah, seven miles from Gaza.

Before the completion of the pipe line the water supply was carried forward in trains of tank cars. These trains were filled at special sidings

British Captured by the Turks Arriving at Jerusalem

and on arriving at railhead were emptied into canvas reservoirs placed beside the track. Here small metal tanks were filled and carried forward on camels to the troops beyond railhead.

When one section of the pipe line was completed a new water siding was provided and the railway relieved of carrying water along that section and so on until water was finally pumped to railhead.

The following is a brief description of the water system when completed:

Water is brought from the Nile near Cairo in the Port Said Branch of the Sweet Water Canal. At Kantara this canal is very close to the west bank of the Suez Canal. Here the Royal Engineers built a thoroughly up-to-date filtration plant having sufficient concrete coagulating basins and mechanical sand filters to treat 600,000 gallons of Nile water per day, and render it apparently perfectly clear to a depth of one metre. As this water is very muddy frequent backwashing of the filters is necessary. The water is pumped from the filtration plant through inverted syphons to masonry reservoirs situated on the east side of the Suez Canal. Centrifugal pumps driven by semi-Diesel oil engines are used for this purpose. The water is chlorinated and then pumped across the desert through a steel pipe line nearly one hundred and fifty miles in length.

This pipe line is lap welded, has screwed joints and is divided into sections each about twenty-four miles in length. The first section of the pipe is twelve inches in diameter, the next ten inches in diameter, and so on, the last section consisting of twin four-inch pipes. Reservoirs and duplicate sets of pumping engines are placed at the ends of each section. At certain points along the desert section of the railway water can be obtained but it is saline and quite unfit for use in locomotives, although used for drinking.

The Water Supply of Jerusalem

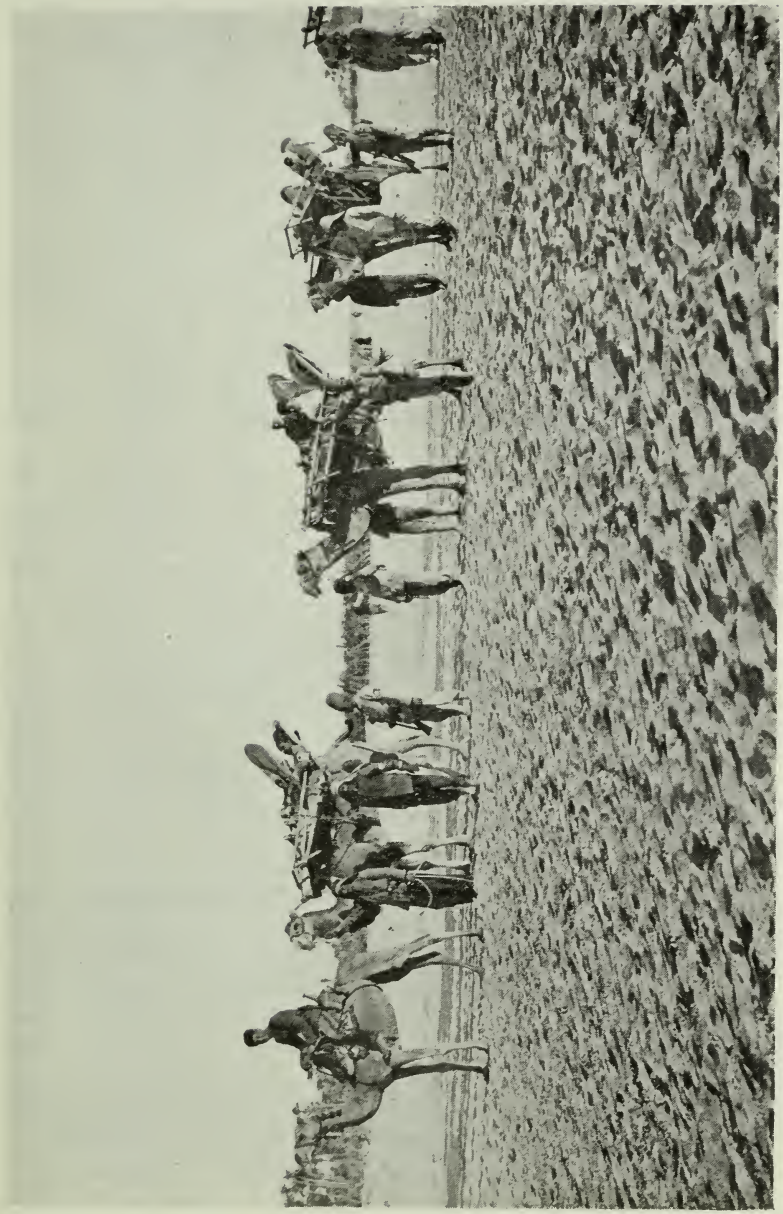
After the army had advanced into the Judean Hills many problems of water supply were successfully solved, one of the most important and most interesting being that of the water supply of Jerusalem.

When the writer first had the privilege of entering the ancient capital of Palestine early in 1918 the water supply came from three main sources.

1. Rain water stored in the cisterns of Jerusalem, a quantity of about 360,000,000 gallons.
2. About 40,000 gallons per day from Solomon's Pools.
3. The Pool of Siloam, which was little better than liquid sewage.

During the winter months the rainfall in Palestine is very heavy and we had much more water than was needed or convenient, but it was necessary to make provision for the coming rainless summer, not only for the troops but also for the 80,000 civilian population of Jerusalem.

The scheme carried out by the Royal Engineers is a modification of the system installed by the Roman Engineers under Herod and Pontius Pilate about 2,000 years ago.



Transporting Wounded on the Desert.

These ancient engineers had brought water through rock-cut channels from the springs of the Wadi Arrub to a reservoir of 4,000,000 gallons capacity, from which it flowed by gravity to Jerusalem through a masonry acqueduct. The Royal Engineers repaired the ancient reservoir and cleared out the channels. They installed a pumping plant to raise the water to a newly erected reservoir of 300,000 gallons capacity from whence it flows by gravity to another reservoir of 200,000 gallons capacity situated on high ground north-west of Jerusalem. The water flows from this reservoir to all parts of the city. Over twelve miles of steel pipes were laid and the whole undertaking completed in the space of nine weeks.

This installation furnishes a supply of 250,000 gallons of water per day and although laid down primarily for military purposes it will be of permanent value to the city.

Roads

Besides the standard gauge military railway and many light railways a great deal of work was done by the Royal Engineers on roads of various kinds.

Satisfactory roads for infantry and motor traffic were built on the desert by stretching ordinary chicken netting over the sand and spiking it down with long staples. When such a road became rough, due to the shifting of the sand, the netting could be lifted and the sand underneath smoothed out again.

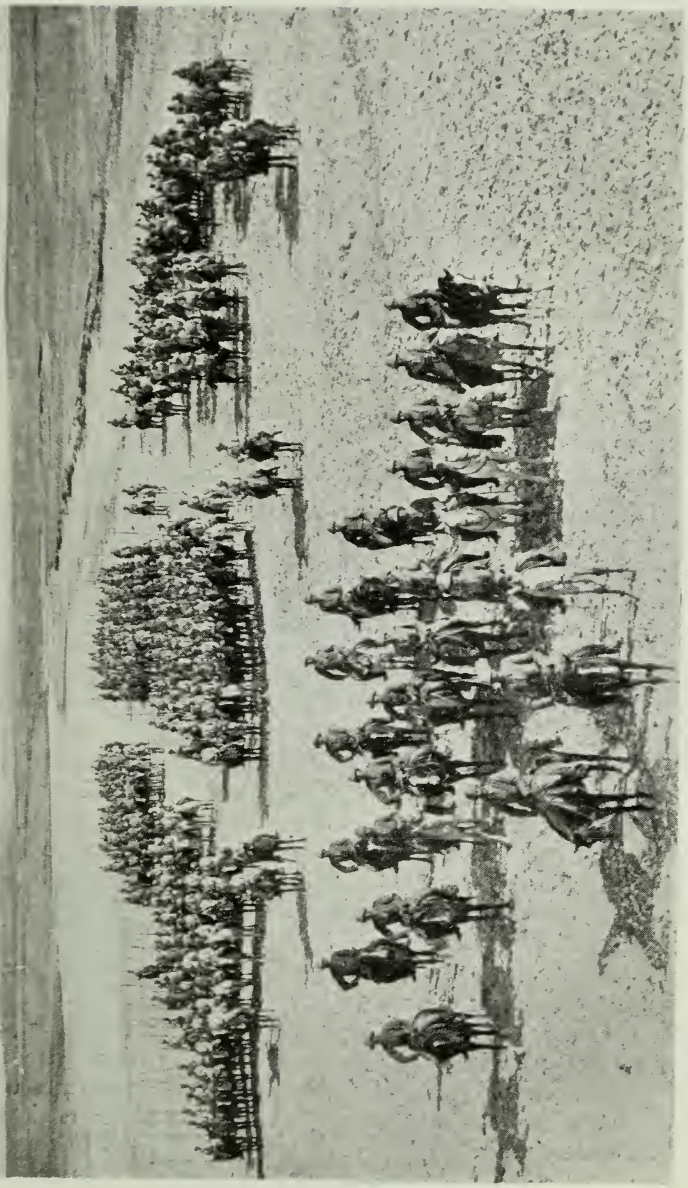
Many permanent roads were built both on the fertile plains and through the hills. In all undertakings the engineers made great use of the Egyptian Labour Corps as well as of the labour which the civilian population of Palestine afforded. It was a common sight to see Palestinians of all ages and of both sexes industriously and cheerfully working at the construction of roads under the supervision of members of the Corps of Royal Engineers, and as far as one could judge all were on the most friendly terms.

Signal Service

A branch of the Royal Engineers worthy of special mention is the Signal Service. The rapid and wide movements of the troops and the great distances traversed made the problem of intercommunication peculiarly difficult. The sudden change from sandy desert to rough mountain tracks called for great elasticity in transport and ingenuity in building telegraph lines. During the most rapid advance, communication was established between the various units by either repairing old Turkish telegraph lines or running new temporary lines. All such lines were replaced later by more permanent ones wherever the circumstances warranted.

Field Survey Campaign

During the great war each British army had a field survey company, operating directly under the intelligence department of the army. In France the Field Survey Companies were latterly called Battalions.



Turkish Cavalry near Beersheba

The 7th Field Survey Company, R. E., of the Egyptian Expeditionary Force, like all other survey companies and battalions, looked after such work as field surveys, compilation and reproduction of maps, photography, letter-press printing, meteorological work, and the location of hostile batteries by means of observation and sound ranging.

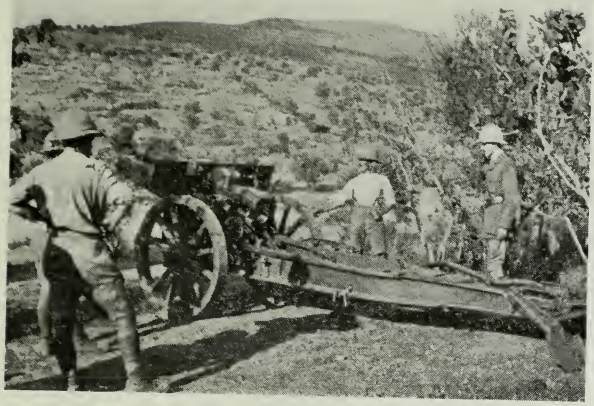
The work of the field parties consisted chiefly of triangulations, plane table surveys, fixing battery positions and datum points for our artillery, and intersecting points in and beyond the enemy's lines. Before the final advance in the autumn of 1918 points had been accurately intersected at distances up to fifteen miles behind the enemy's front line.

Contour maps were printed on the scales—1/40,000, 1/20,000, and 1/10,000. The operation maps on the 1/40,000 scale were printed in four colors. The wadis, roads, railways, villages, wells and such topographical features were printed in black, contours in brown, trees in green and enemy trenches, gun emplacements, barbed wire entanglements and earthworks in red over black. Different classes of roads were also indicated in red.

Contours were surveyed at twenty metres vertical interval in the hilly country, and at ten metres in the plains; spot heights were also taken of the hills. Some sheets were overprinted with a special grid subdivision and enemy battery positions numbered in blue.

The Royal Air Force photographed the whole of the enemy's line and country in the rear to a depth of twenty-five miles, and in addition the main roads and railways leading from the north. Between Jan. 1st, 1918, and the cessation of hostilities, 15,690 photographs were dealt with and the topographical information published in map form. The photographic section of the Royal Air Force showed the greatest willingness to co-operate with and meet the requirements of the Field Survey Company with the result that photographs were used in the compilation of topographical detail maps in the Egyptian Expeditionary Force to perhaps a relatively greater extent than on any other front. Maps showing the disposition of the enemy's forces, to accompany intelligence summaries, were printed periodically. During active operations these maps were printed at night for distribution to units in the field in time for the following day's operations. Such maps were issued for some sixty days. Twenty-six telephoto panoramas were taken from a number of positions commanding good views over the enemy's ground. Two topographical sections were formed in 1918 to compile and print small maps of the enemy's defenses as required. Astronomical observations were made at various places to determine the latitude and longitude.

The meterological section took daily readings of the maximum and minimum temperatures. Humidity, barometric pressure, evaporation, wind and rainfall were recorded four times a day. Daily weather reports were



Captured German 15 c.m. Howitzer in Wadi el Jib near H.Q. "V" Section firing on Turks.

H.Q. "V" Section from across Wadi el Jib.

"A" Post "V" Section Khurbet Abu Felah

issued. Measurements of the upper air currents were made by the observation of the flights of small pilot balloons. During artillery activity balloon flights were observed at intervals of four hours during the day and night.

Sound Ranging

In August, 1917, two sound-ranging sections, "V" and "N" were sent from France to the Palestine front and in August, 1918, a third section was formed locally in order to use a spare set of sound ranging instruments which had just been sent to Palestine.

Previous to August, 1917, "V" Section, R. E., was part of the 3rd Field Survey Company in France, the headquarters of "N" Section being at Velu, between Bapaume and Cambrai. "N" Section was part of the 2nd Field Survey Company. Scientific sound ranging, as carried on in the various British armies as well as in the armies of our allies, should not be confused with the rough and ready method of observing sound bearings where direction is judged by hearing alone. Our method differed greatly from that employed by the enmy. We obtained records of great precision in which no human element existed, whereas the enemy depended entirely upon the skill of his observers, and a very rigorous discipline designed to make the observer do their best.

We employed an extremely accurate electrical device to give us photographic records, from which intervals of time could be easily read to the nearest 1/100 of a second, and in many cases. to the nearest 1/1,000 of a second, if required. The enemy employed a man with a stop watch for this purpose.

Fig. 1 is a rough plan of the first position of "V" section in Palestine. It shows the positions of the six microphones, of the two advanced or observation posts and of the headquarters of the section.

The distances in metres that the microphones were, east and north of the origin of the survey of Egypt, are given by the numbers on the plan which are placed close to the respective microphone positions. The microphone positions were determined with the greatest possible precision and if a blunder were made in the location of one or more microphones, as frequently happened, it became apparent as soon as the sound ranging instruments were used.

No one was stationed at any microphone position, but at each advanced post there was always an observer on duty with a switch key in his hand. It was the duty of this observer to press the key whenever he heard an enemy gun and keep it pressed until he heard or saw the shell burst.

All information which could be obtained by seeing or hearing was telephoned at once to headquarters, either by the observer holding the switch or by one of his companions. Each microphone and observation post was connected to headquarters by means of two wires. By using the earth as a third conductor between headquarters and the advanced

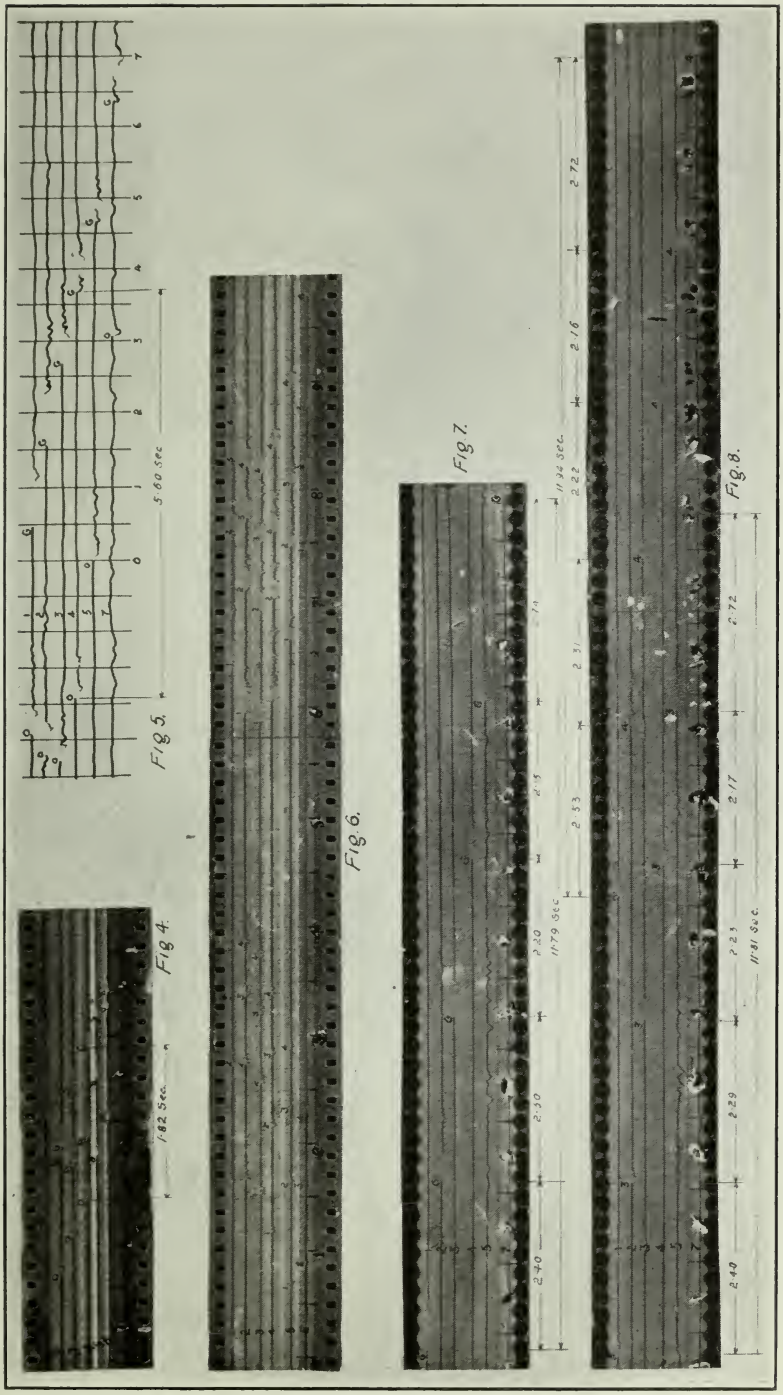


Fig. 4.
1·82 Sec.
Fig. 5.
5·60 Sec.
Fig. 6.
Fig. 7.
11·79 Sec.
11·94 Sec.
Fig. 8.
11·81 Sec.

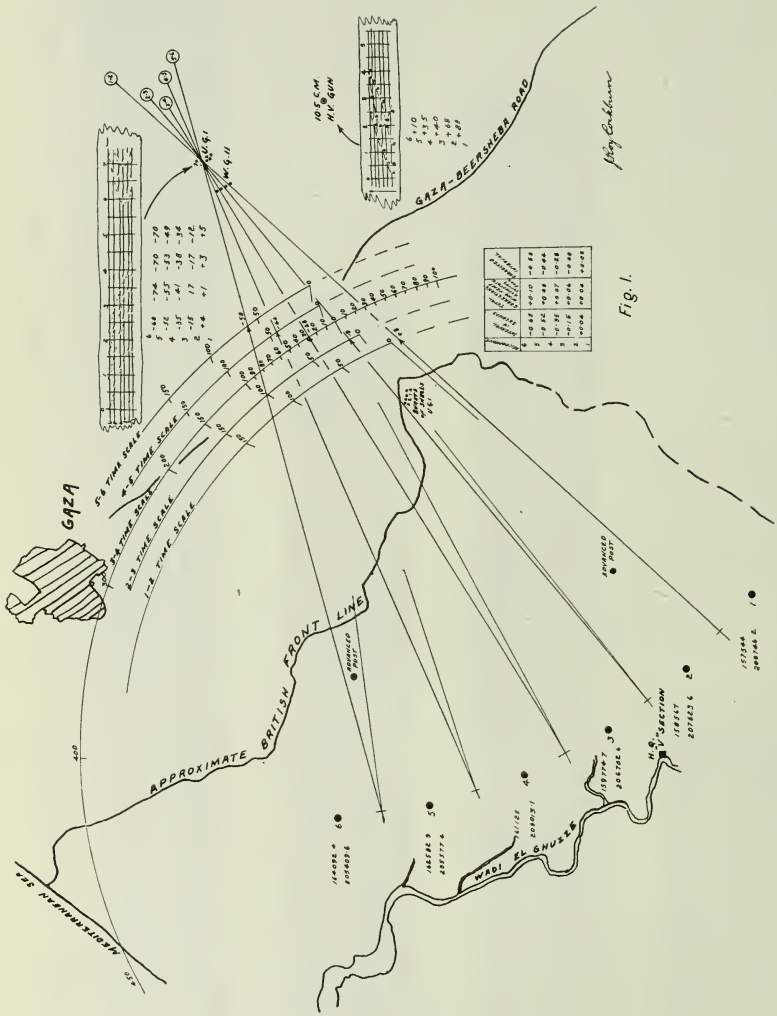


Diagram Illustrating Computation of Hostile Battery Position from Film Record Reproduced in Fig. 6.

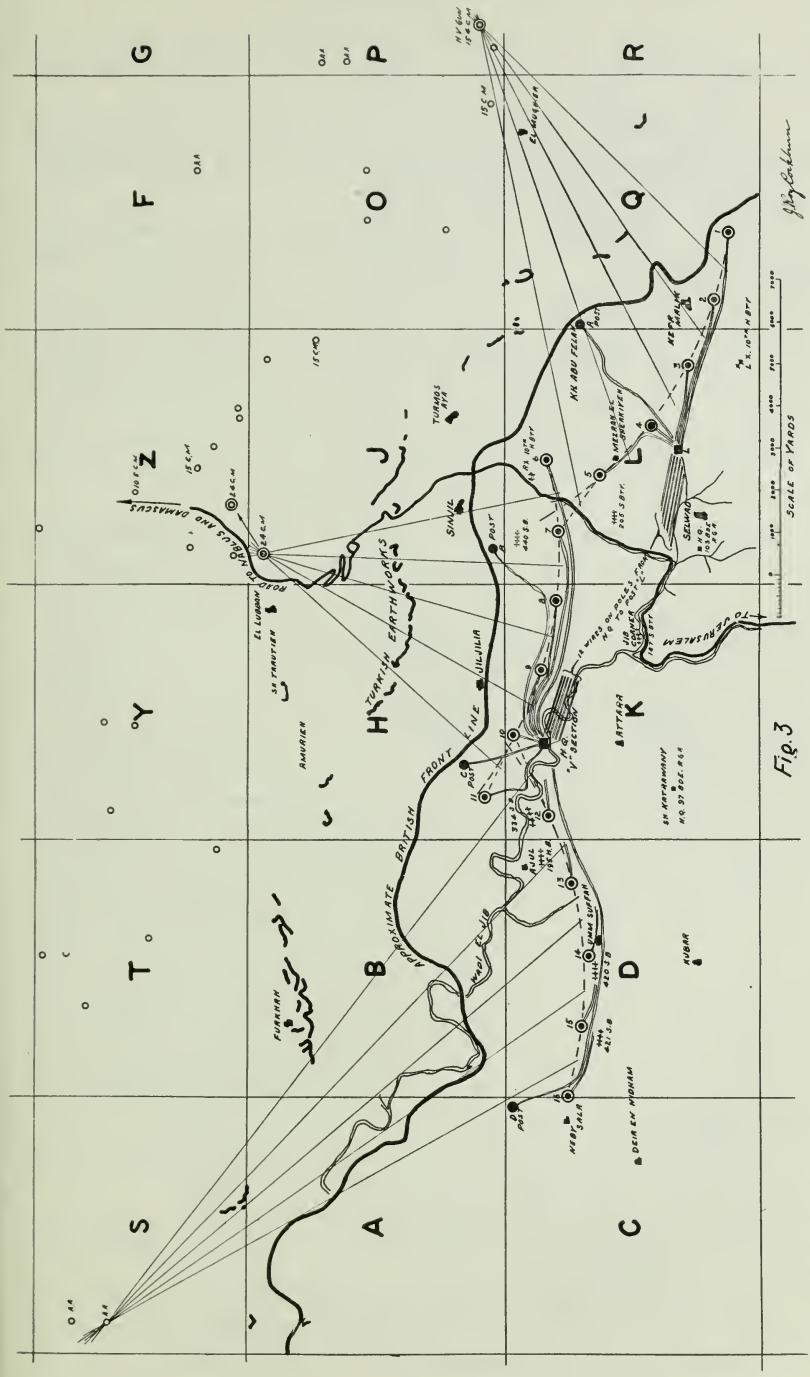


Diagram Showing Positions of H.Q. Microphones and Advanced Posts of "V" Section on the Sinjil Front.

posts, it was possible to operate the telephones with complete metallic circuits, and at the same time use the starting or relay switcnes in the hands of the observer without any mutual interference.

It was important that the telephone circuits should be independent of the earth, because the enemy was always ready to pick up our messages from telephone or telegraph lines.

In Fig. 1, the positions of two 15 centimetre German howitzer batteries, U. G. 1 and W. G. 11 and one 10.5 centimetre German high velocity gun are shown.

Fig. 2 is a reproduction of a film record used in locating the position of U. G. 1. It gives the necesary information to compute the positions of the four guns of the battery, all of which fired within the space of two seconds; also the positions of the bursts of the four shells, and, consequently, a fair idea of the calibre and type of the guns.

This film record indicates that the four guns are 15 centimetre howitzers, 1913 patterns, firing the sixth or largest charge.

Whenever sufficiently large pieces of enemy shells could be picked up, they were accurately measured and the information used to identify the guns. A few days before the III Battle of Gaza, U. G. 1 commenced firing on our front line. It was immediately located and one of our 6-inch howitzer batteries ranged on it. During the shoot W. G. 11 commenced firing with, as we judged, the intention of confusing our sound ranging records. The result was that we obtained a good record of W. G. 11, which proved to be exactly in line with V. G. 1 and our battery, and almost exactly 650 yards closer than V. G. 1. This enabled our battery to carry out a destructive shoot on both the hostile batteries. A few days later, after the Turk had been driven back, it was found on inspecting the ground that all eight gun pits had been heavily shelled and the ammunition scattered around and buried by our shells. The enemy guns had been removed. Fig. 3 is a film record of the 10.5 centimetre, high velocity gun indicated in Fig 1. The points marked "O" refer to the so-called "Onde de Choc" or "Shell Wave." This shell wave always occurs when the muzzle velocity of the shell is greater than the velocity of sound in the air. After the velocity of the shell has decreased to that of sound, this wave travels ahead of the shell and muzzle report, much as the waves from a vessel travel on ahead, when the speed of the vessel is reduced below that of the natural velocity of the waves in water.

The points marked "G" refer to the muzzle report of the gun and are the ones used in computing the gun's position.

The points marked "B" refer to the burst of the shell.

From the relation between "G" and "B," the time of flight of the shell can be computed.

Just before the Third Battle of Gaza, hostile batteries were plotted on the topographical maps from both aeroplane photographs and sound ranging reports; and it was discovered that, in a certain section, the two dis-

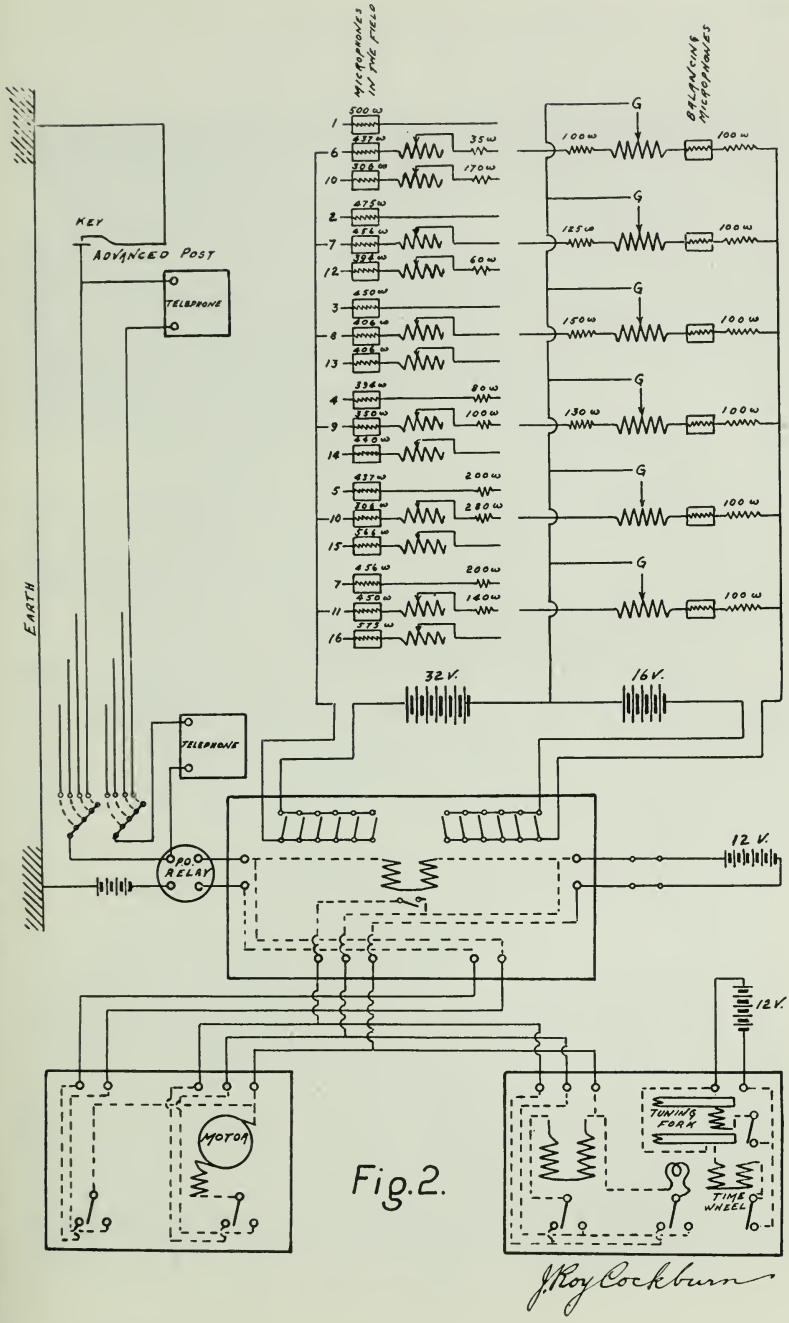


Diagram of Electric Circuits, "V" Section, Sinjil Front.

agreed fairly consistently to the extent of about 150 yards.. This was taken at G. H. Q. to prove that the sound ranging records were inaccurate, to that extent; but "V" section resolutely maintained that it proved that the topographical detail was wrong. After the Turk was driven back, the ground was accurately surveyed and a new map issued, in which it was found that the discrepancy of 150 yards had almost entirely disappeared.

Fig. 3 illustrates the installation of "V" Section on the Singil Front during the summer of 1918—the only case in which one sound ranging section operated at the same time three sound ranging bases. The three bases were operated from a common headquarters and the efficiency was nearly as great as could have been obtained by operating each base from a separate headquarters. All of the special appliances needed for the three base installations, including nine of the microphones were designed and constructed in the field by the personnel of "V" Section.

As the recording instruments were originally constructed for use with a single base of six microphones, six only could be used at the same instant, but it was possible by moving a single handle to instantly change from any one of the three bases to any one of the others without upsetting the extremely delicate adjustment of the system.

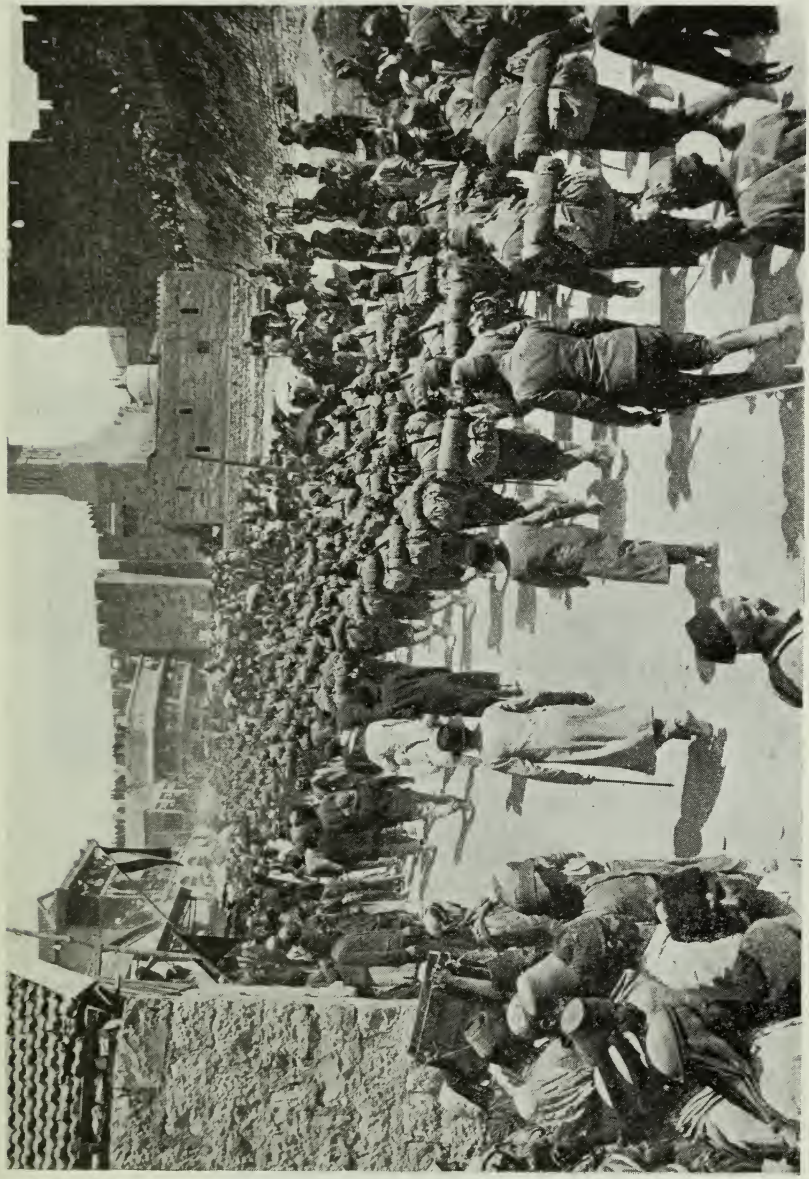
The points which are numbered are microphone positions. It might be noted that No. 7 did duty with both the right hand and centre bases, and No. 10 with both the centre and left hand bases.

The points marked A B C and D, indicate the positions of the forward or observation posts at each of which an observer was always on duty.

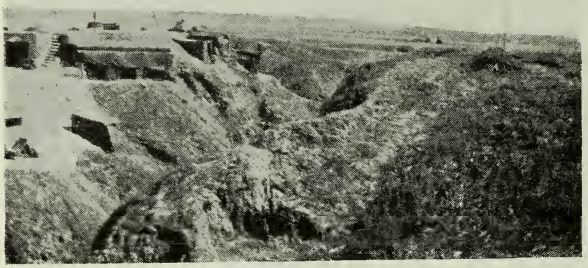
Fig. 2 is a diagram of the electric circuits of "V" section corresponding to the position shown in Fig. 3.

Instead of using the regular Wheatstone bridges for which the instruments were designed, the connections to the galvanometer were made as shown. This allowed two arms of each bridge to be eliminated, thus effecting a considerable saving in current consumption and adding to the sensitivity of the instruments. The balancing microphones shown in the diagram were first tried while on the Gaza-Beersheba Front. Their introduction resulted in the elimination of a very serious fault in the sound-ranging records.

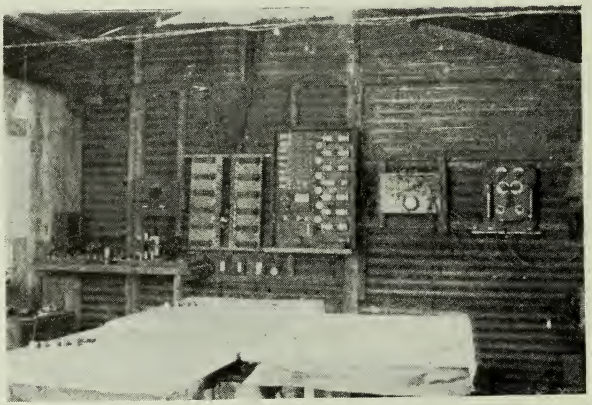
A general idea of the actual operation of a sound ranging section can be given by describing the work of the Left Section of the 10th Heavy Battery and "V" Section in silencing "Jericho Jane," a 15.4 centimetre gun with a range of at least 20,500 yards, the longest range of any gun in Palestine.



Austrian Troops Marching Into Jerusalem. Tower of David in Right Hand Upper Corner and Jaffa Gate near the Centre.



H.Q.
"V" Section
at
Um Jerrar
between
Gaza and
Beersheba.



Recording
Instruments
and
Computing
Boards,
H.Q.
"V" Section.

Officer's Mess
"V" Section
in
Wadi el Jib.

Turkish Camel Corps at Beersheba.

On July 13th, 1918, at 9.20 p.m., this gun commenced firing on Jericho. Immediately the observer on duty at "A" post heard the report of this gun, he pressed his key, thereby closing the relay current. This switched the current on all the microphones of the right hand base. It excited the field of the Einthoven galvanometer which contained six platinum wires, one for each microphone circuit. It started the motor driving the moving picture film in the recording camera, and it turned on the fifty candle-power lamp which furnished the light for the photographic record.

The only part of the instruments kept constantly running was a timing device, driven by a synchronous motor, the speed of which was controlled by a tuning fork, making approximately fifty vibrations per second and interrupting the current supplied to the motor.

From the photographic record of the relative times at which the sound arrived at the six microphones, the time differences were obtained. The temperature of the air and the direction and velocity of the wind were observed and the necessary corrections applied to the time differences. A small correction was also made for the error of the tuning fork.

The velocity of sound in still air of average humidity at a temperature of 50°F is 369.1 yards per second. The time differences were therefore functions of the differences of the distances of the various microphones from the gun. For any one familiar with the properties of hyperbole and their asymptotes, the rest of the process is evident. The location of the gun was worked out graphically on a special computing board covered with a sheet of zinc, which was in turn covered with a sheet of drafting paper glued to it. Under ideal conditions the whole process from the firing of the gun to the finished location could be done in four minutes. On one occasion a computer at "V" section struggled with a very puzzling record, off and on, for twenty-four hours, with the result that he eventually obtained an extremely accurate location of a 15 centimetre howitzer, for which we were ready the next time it fired.

Instantly "Jericho Jane" was located, its position, (P32a0030) was reported to the Counter Battery Staff Officer of the XX Corps, who immediately assigned the left section of the 10th Heavy Battery (LX10HB in the diagram) to retaliate, no other British guns being within range.

The following is a record of the shooting of L X 10H.B.:

First shell from No. 3 gun—300 yards short, 150 yards right.

First shell from No. 4 gun—200 yards short, 50 yards right.

First group of three from No. 3—Range correct, 50 yards right.

First group of three from No. 4—100 yards short, 100 yards right.

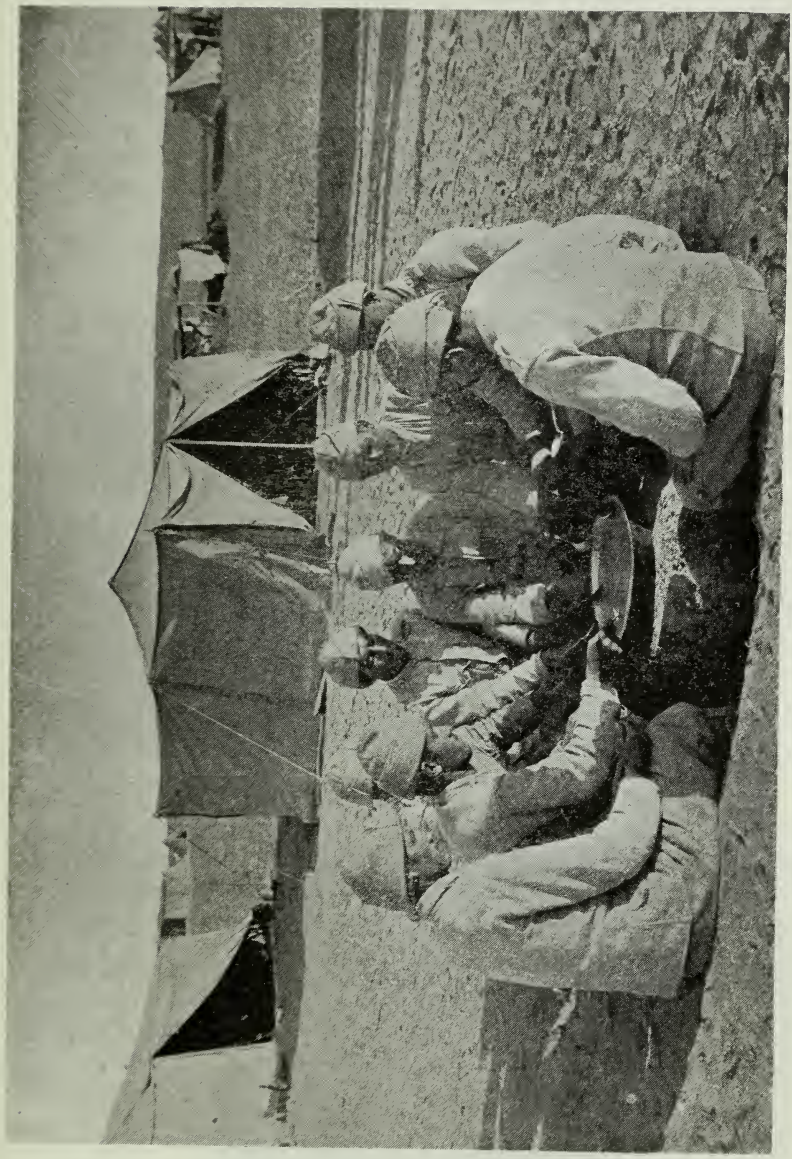
It was here noticed that the correction had been applied the wrong way to No. 4 gun, hence the 100 yards right.

Second group of three from No. 3—50 yards short, line correct.

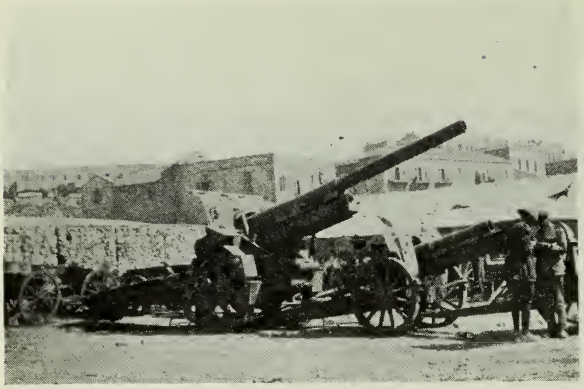
Second group of three from No. 4—50 yards short, 50 yards left.

Third group of three from No. 3—70 yards short, line correct.

Third group of three from No. 4—O. K.



Turkish Troops Eating



15 4 c.m. H.V. Gun "Jericho Jane" in I.O.M.'s Yard at Jerusalem.

H.Q. "V" Section in Wadi el Jib.

"D" Post "V" Section.

Group of eight rounds from No. 3—O. K.

Group of eight rounds from No. 4—40 yards over, 20 yards right.

The left section of the 10th Heavy Battery fired in all sixty rounds; the last groups of three from No. 3 gun were O. K., and from No. 4 gun, range correct, 20 yards right.

During the firing of the groups of eight rounds which were registered by "V" section, "Jericho Jane's" ammunition was set on fire and the gun ceased firing.

"Jericho Jane" was only one of fourteen batteries located by "V" section between 8 a.m., July 13th, and 8 a.m., July 14th, and shoots were conducted on two of the others during that period.

In ranging our own guns on an active hostile battery, it was unnecessary to apply any corrections, because the errors would be the same for the location of the enemy gun and would, therefore, cancel each other; but in obtaining map locations of batteries or ranging our guns on batteries after they had ceased fire, we were very careful in applying corrections. One of the most unsatisfactory things about sound ranging was our inability to correctly observe the constantly changing wind and temperature in the hilly country.

Fig. 7 is a film record of "Jericho Jane" firing at Jericho. As the line of fire was almost at right angles to the line joining the gun position to our nearest microphone, no shell wave was registered on any of the microphones.

Fig. 8 is a film record of the bursts of two shells from the 10th Heavy Battery. It shows No. 3 gun to be O. K. and No. 4 gun 40 yards over and 20 yards right of the target.

During the summer of 1918, 'V" section made a total of 1,106 locations, distributed over 167 hostile battery positions and also conducted 63 sound-ranging shoots involving the location of 1,515 rounds fired from our own guns.

Fig. 5 is a record of "Jericho Jane" firing almost directly over No. 4 microphone. It is clearly shown that the shell wave was 5.60 seconds in advance of the muzzle report. In Fig. 4 the corresponding interval for the 10.5 c.m. H. V. gun is shown to be 1.82 seconds and in Fig. 6 it is shown that no such interval exists in the case of the 15 c.m. howitzers.

Even should space permit, it would scarcely be advisable to give here a detailed description of the apparatus or of the fine points of sound ranging.

British Artillery in the Foreground. Jerusalem in the Background.

Both the enemy and ourselves employed the same mathematical principles, but the success of the British method depended upon the many refinements which were introduced from time to time. The most important and unique device used in sound ranging was invented by Mr. Tucker, an officer of the first British sound-ranging section. This device, although generally adopted, was guarded with great secrecy and the principle upon which it worked known only by those directly interested in sound ranging. The last time the writer saw Mr. Tucker, many months after the adoption of his invention, he was still wearing the single star of a Second Lieutenant in the Royal Engineers.

Each detail of sound ranging was worked out during the Great War and every progressive sound-ranging section was constantly experimenting and improving both the apparatus and method.

When the Turk was driven out of Jerusalem in December, 1917, by the British, he had intended taking the civilian population with him but his exit was so hurried that he even left behind Mr. C. Raad whom he had been employing as official photographer. The photographs of the Turkish troops which are here reproduced are a few of a set obtained from Mr. Raad. The small photographs were taken with a vest pocket kodak and developed at H. Q. "V" Section while in the field.

The ragged appearance of the sound-ranging records which are reproduced is due to the fact that only a few seconds were spent in developing them.

CONFERENCE ON WATER POWER DEVELOPMENT

By Robert W. Angus, B.A.Sc.

The second conference on water power development was held from Feb. 19th to 27th, 1923, at the University. Like the former one, the one this year was arranged by the writer for the purpose of bringing before the students some of the engineers who are dealing with the practical affairs of life, and who, therefore, come with a freshness that is not possible to bring from inside the walls of the University. In addition to that these gentlemen are able to point out lines of procedure which have met with success, and to give an inspiration and enthusiasm for hydraulic work.

In every case great care was taken in securing the speakers, and all of them were invited as a result of my personal knowledge of their qualifications, so that there was not a speaker who did not bring a message well worth while. The speakers all hold positions of much responsibility and their names are well known in America.

Owing to the objects of the cause, as set before the speakers, the addresses proved of much value to practising engineers, and the interest taken by them was shown by the large number who attended the course.

The subjects for the addresses were selected with the idea of covering the entire field of water power development, although it was not possible to arrange the lectures in logical order, and therefore the course covered financial considerations, preliminary survey, stream gauging, turbines and governors, testing and operation, each being dealt with by a specialist in his own branch.

Design of Water Power Plants as Affected by Financial Consideration

By J. L. Harper

The first address in the Conference was given by Mr. J. L. Harper, Chief Engineer and Vice-President of the Niagara Falls Power Co., Niagara Falls, N. Y. Mr. Harper is well known to engineers throughout America in connection with this company, and it is largely to his effort that the success of the company is due.

Mr. Harper proved a most interesting and entertaining, as well as a very witty speaker. In discussing the design of water power plants he laid great stress on the importance of building such works with a view to the best interests of the public service rather than that of undue economy, giving instances where extra outlay well repaid the expenditure, on account of the resulting improved efficiency.

The speaker emphasized the value of quiet thinking and said that he had got much of his education on the farm where he could develop his ideas undisturbed. He discussed many of the difficulties which great'y increase the cost of a water power plant, explaining that experience alone

teaches the engineer what he has to contend with. Mr. Harper pointed out that while people frequently speak of water as being free of cost for power, the same statement might also be made of coal, as both coal and water are free in a sense in the place where nature has produced them, but just as the cost of coal to the consumers is based largely on that required to take it from the mine and transport it to the place where it is used, so the cost of water used becomes large when one considers the amount of money and thought necessary to bring it to the turbines in an available form.

Some of the obstacles met with were discussed, such as the needs of navigation, danger from ice, and logging operations, and the speaker gave a curious instance in which a cemetery prevented the use of land for water storage and allowed only about half of the water power available to be used.

The lecture closed with a few slides of the new tunnel recently built in Niagara Falls.

Preliminary Studies and Estimates for Water Power, and Moving Pictures of Some Leading Hydraulic Plants

By H. G. Acres

The speaker on this occasion, Mr. H. G. Acres, graduated from this University in 1903, and, with the exception of about a year, has engaged in hydro electric work ever since. He is chief hydraulic engineer of the Hydro Electric Power Commission and took a very active part in the construction of the Chippawa plant.

Mr. Acres' address had to do with the general preliminaries in connection with the layout of a water power plant, and he discussed quite fully the various factors entering into the selection of a site and the method of studying the effect of these different factors. He selected several different plants, put in by the Commission, as illustrations and showed how the scheme would be tentatively laid out from the general knowledge of the country and the capacity of the various streams.

After the preliminary idea is evolved, careful studies are made with regard to the flow in the stream, the fall available at different points in it, the variation of the flow at different seasons of the year and the possibility of marketing the power; and from these studies the final layout of the plant is made and then the detailed drawings are worked out.

In his second address Mr. Acres showed pictures of some of the Commission's plants, more especially that at Chippawa, and the illustrations proved to be particularly interesting in showing the detailed method of carrying out a job of that magnitude.

Methods of Measuring Stream Flow and of Estimating the Available Water Supply

By C. C. Covert

This lecture was given by Mr. Covert, who has had an exceptional amount of experience on stream flow measurements, as he had been con-

nected for many years with the United States Government on the Water Supply Section of the Geological Survey, and he was therefore thoroughly conversant with the details of such work. At present Mr. Covert is with the W. & L. E. Gurley Co., for whom he is redesigning parts of their stream measuring apparatus.

The address proved to be of particular interest because Mr. Covert laid stress on serious errors that were likely to creep in in making measurements of stream flow, and pointed out that the actual measurement taken might represent very much more or very much less than the flow in the stream. In this connection he emphasized the need of selecting the measuring station at a point where one had some control of the stream, and said that an artificial control should be put in if a natural control was not available. That is, the gauging station would be put just above the rapids, over which there would be a definite depth of water, this depth being to a large extent a measure of the flow, and, if actual rapids were not available, he said that an artificial dam would be erected.

By this means the effect of back water would be avoided and this is very essential because back water means storage of flow which should be going over the dam.

The desirability of automatic water stage recorders was emphasized, as these keep track of the flow throughout the entire day, and, in certain illustrations, Mr. Covert showed that too few observations often led to serious inaccuracies owing to the varying nature of the flow in some streams.

The method of checking the measurements by plotting velocities, areas and discharges was also explained by Mr. Covert, and his whole address proved to be of particular interest.

Modern Hydraulic Machinery, Turbines and Governors

By W. R. Keppler

This address was to have been given by Mr. D. J. McCormack, Chief Engineer of the Wellman-Seaver-Morgan Co., Cleveland, and a man who has had to do with the design of many of the largest turbines in use to-day. Unfortunately Mr. McCormack was delayed through illness, and so his place was taken by Mr. Keppler, of the same company, who proved to be an exceedingly good substitute.

Mr. Keppler sketched the advances made in modern turbine design from the earlier stages of about twenty years ago. He showed how the earlier plants had as many as six runners on a single shaft and how the twisting of the gate operating shafts gave such variable loads on the turbines as to cause much difficulty in control. He also discussed the various types of gate mechanisms, and explained the improvement which had been made in these recently, in the way of making the mechanism more reliable through placing the links outside, where they would not be subjected to the deteriorating effects of the water. Toward the end of the lecture Mr. Keppler discussed governing, and the making of the new type governor, showing various improvements which had been made and what these had

resulted in in the way of efficiency, and intended to go into a complete discussion of the remote control and the independent governor. Unfortunately the time proved altogether too short and it was a matter of regret that an extra hour was not available for the discussion of governing alone.

The Testing of Hydraulic Turbines and Measurement of Efficiency

By Professor C. M. Allen

One of the most interesting lectures in the entire course was given by C. M. Allen, Professor of Hydraulic Engineering at Worcester Polytechnic Institute, and a consulting engineer with a very extensive practice, mainly in turbine testing and the development and improvement in their setting.

The methods of testing used by Professor Allen proved to be quite new to most of the audience, as he has not been using the electric generator for producing the load and calculating the turbine output from measurements on the generator, but wherever the turbines have been tested he has removed the generator or pulp grinder or whatever load was there and substituted for it an Alden dynamometer. The development of these dynamometers has been made by Professor Allen in conjunction with George I. Alden and they have brought the apparatus to a very good state of perfection, so much so that they are able to apply them to turbines of quite large powers.

When the turbine is to be tested, Professor Allen selects a dynamometer from his stock and ships it to the place where it is to be used, then attaches it to the machine in place, which often requires a good deal of special setting. Slides explained by the speaker showed him to be a very resourceful man indeed in the way of erecting his apparatus, with very little equipment, and his method of getting the zero loads of the dynamometers with all the equipment in place, were very nicely presented.

The second part of this lecture dealt with the method recently devised by Professor Allen for the measurement of the quantity of water flowing to a turbine, his method consisting of placing in the pipe a penstock, at two different points, a pair of insulated terminals to which 110 volts is applied, and an ammeter in the same circuit shows the current flowing, which will of course be very small owing to the small conductivity of the water. When a measurement is to be made, a quantity of salt is injected into the pipe above the first pair of terminals and the time that it passes under the terminals is indicated by a marked increase in the conductivity of the water, so that by noting the readings of the ammeters at the two points the exact time of flow of this salt solution is easily determined, and from it a very simple calculation gives the mean velocity in the pipe.

The method has met with a great deal of success and the speaker said that his results had given an error much less than one per cent. as compared with volumetric measurements in a tank. It is particularly gratifying

that this method was described at this lecture, for the second time only, in public, and we were, therefore, fortunate in having Professor Allen address the meeting.

The last speaker in the course was Mr. Don Carlos, who is head of the operating department of the Hydro Electric Power Commission, and has had to do with the operating of their plants for a number of years, proved very successful in his work. He is a graduate of the University of Missouri. This lecture is printed in detail elsewhere.

OPERATION OF WATER POWER PLANTS

Mr. H. C. Don Carlos, Hydro-Electric Power Commission

Address delivered at Water Power Development Conference at the University, Feb. 27, 1923.

Professor Angus has referred to me as a practically trained man. This does not occur to me as being any particular distinction. Any engineer must be a practically trained man. The greater part of all our engineering training and education is obtained outside of what is usually termed our engineering course.

Your degree and diploma is conferred upon you when you have completed the prescribed course in the University, but your real engineering education is obtained outside the University. Most of you, when you have obtained your diplomas, will take them home and put them away in your trunks and forget all about them. I have a diploma some place around the house from the Missouri State University, but I don't even know where it is.

I don't want any of you to misunderstand me as speaking lightly or disparagingly of your University course or the importance of studying hard and doing good work. Your University course is of great importance as a foundation for your engineering training. But don't get the idea that when you have completed your University course, and obtained your degree and diploma, that you are an engineer—you are just ready then to start your real engineering training.

Those of you who expect to follow engineering should get out and learn to do things by doing them yourself.

At this point I should like to draw attention to the value of engineering experience which it is possible to obtain from being directly in touch with the operation and maintenance of mechanical, hydraulic and electrical equipment in service. In my opinion there is no place in the world where a man can get a more valuable experience to fit him for design work, than that of being in direct touch with the performance of equipment in service. Such experience is also of value in educating a man to the importance of layout and is also invaluable to him when he may be called upon to select equipment for any given service. I have noticed that there seems to be

an aversion on the part of young graduates to go into this class of work. They seem to prefer the drafting room or office or shop. Shop experience is no doubt of great value but I maintain that a man should have actual operating experience before qualifying as a designing engineer for either equipment or layout.

Don't expect, as soon as you get out of school, to go out and get an engineering position, go out and get a *job*. My first job when I had finished my course in electrical engineering was digging post holes and, having had previous experience at farming, which has to do with the soil, I did fairly well at the job of post hole digging. Then I learned to climb poles, (the linemen called it hiking), and I think probably I was as great a success at this as Mr. Harper was at cleaning horse manure off of street car motors. I think I was considered a first class lineman at one time. At any rate I could handle myself as well on a pole and do as much line work as any of the men I came in contact with. This experience has, I consider, been of considerable value to me.

I learned the blacksmith trade before I went to the University, and during my University course I would go out and work at blacksmithing during the summer vacation. This experience has also been of value to me. Within the last two years we had occasion to do certain repair work on a section of wood stave pipe line at one of the plants. This necessitated a complete shut down of the plant and, of course, we took advantage of the most opportune time which was over a Sunday and holiday, which came consecutively. During the course of the work some special tools were required and as there was no blacksmith available I had to turn in and make the tools myself, which I was able to do on account of my previous experience in this class of work.

The H. E. P. C. at present own and operate 19 hydro-electric and two steam generating stations, which are supplying power through a large number of transforming stations and about 3,200 circuit miles of transmission lines throughout the Province of Ontario.

It is the primary duty of the operating staff to deliver power from these plants and over the transmission and transforming systems, as demanded up to the capacity of the plant, also to maintain the plant in such condition that it will be capable of delivering power when required. This necessitates maintaining a considerable staff with a great diversity of qualifications capable of performing from the simplest operations such as handling an oil can and cleaning machinery to such complicated problems as completely dismantling and rebuilding turbines, generators, governors, transformers, etc., and making studies of water and ice conditions.

In case a piece of equipment of any kind breaks down in service, or fails to properly perform the function for which it was intended, the reason for the failure and the accompanying conditions, must be carefully studied, and in making repairs the weaknesses or defects must be eliminated if possible, and any objectionable conditions removed.

It follows, therefore, that while the design and construction of the plants do not come strictly within the duties of the operating department, there are many features in the design and construction regarding which they should be consulted.

Simplicity and Accessibility

Two of the most important features in any type of equipment from the operating standpoint are simplicity and accessibility.

These can be sacrificed to some extent where necessary to get the highest efficiency in large main turbines in a plant, but in the case of the auxiliary or service units, on the continuous operation of which the whole of the output of the plant depends, simplicity and accessibility for examination, adjustment and repairs should be one of the principal considerations in the design. The actual output from such machines is only a small percentage of the total output from the plant and a slight loss in the efficiency of these small machines would not be noticed in the total output, while an excessive time to make repairs may interfere with the output from the whole plant. Horizontal units are, in my opinion, more desirable from this standpoint for service units than vertical units.

Erosion

Erosion is probably caused by air freed from the water when passing through the turbine, due to sudden changes in pressure. This air may contain an excess of ozone or oxygen in a nascent condition, and has a very marked effect on iron and steel, and to a lesser extent on bronze. Pitting, or a sort of honeycombed condition of the surface, is produced and when once started is cumulative, due to the destruction of the smooth surfaces of the vanes. In some cases large cavities have been eaten out of the runner vanes in a very short time.

Owing to the development, in recent years, of electric welding, this is not such a serious matter as formerly. Turbine runners of bronze, steel or cast iron can now be successfully repaired by electric welding. This has practically revolutionized turbine maintenance. We have successfully built up bronze runners, which five or six years ago would have been consigned to the scrap heap. We have built up worn bronze wearing rings and have repaired broken runner vanes in place. The possibilities of this process are so far reaching that they deserve the immediate attention of every power plant management.

Valves

The valves used to cut off the water from the individual turbines or penstocks require periodic inspection, and, depending on the type of valves used, may, after long periods of operation, require extensive repairs and renewals.

Three main types of valves are used for this purpose, ordinary gate valves, butterfly valves and Johnson valves. Butterfly valves and Johnson valves are more suitable for high pressures and large sizes due to the difficulty of operating large gate valves under high head. While butterfly valves are much cheaper than Johnson valves, they are much more diffi-

cult to make watertight. Neither of these types require much attention aside from regular operation at intervals of three or four weeks, to prevent rust and silt accumulations from making them stick. The Johnson valves, however, being hydraulically operated and controlled from penstock pressure, we have found it advisable, where there is a great deal of ice liable to be present in the water, to have a second source of water pressure available for their operation.

The large gate valves at the O. P. plant are operated by electric motors and are quite reliable within their limits until the screws and nuts become badly worn. We found in the case of some of these valves that after eight or ten years operation, the screws and nuts had worn so badly that the valves were likely to become inoperative. They were of the stationary stem type with the screws turning through nuts fastened in the gate, which moves to and fro as the screws are rotated by gearing. The screws and nuts being under water, and inaccessible for lubrication, became covered with rust and dirt which gradually ground away the threads. It would be a comparatively simple matter to repair these if the pipe line above the valves could be unwatered whenever work was to be done, but since this was impossible the problem was one which required some study and much hard work for its solution. Without burdening you with details, I may say that we have successfully replaced the screws and nuts in practically all of these valves without losing the service of a unit at any time when required for load. At the same time, the design of six of these valves was changed to the rising stem type with outside nuts operated by gears, an arrangement which we are confident will avoid trouble with screws and nuts wearing out so rapidly in the future.

Lubrication

Of course a continuous supply of oil must be provided for all the bearings, and in large size bearings where any considerable amount of heat is generated, it is necesary to dissipate a part of this heat by cooling the oil. This is done either by water cooling coils in the bearing or by pumping the oil through a cooling system or both. In horizontal machines it is often the practice to provide a large oil reservoir under the bearing with cooling coils, then the oil is carried up into the bearings by oil rings. In this case the oil is not circulated outside the bearings. It is self-contained and requires very little attention. Other than this there are two main systems in general use.

(1) Gravity system.—In this system the storage tank is placed at a considerable height, depending on the oil pressure required, and the oil is fed from the storage tank direct to the bearings, then it drains away to a sump tank and is pumped back to the storage tank after being filtered. The gravity system has a great deal in its favour; it provides uniform pressure which is very important in regulating the supply of oil to the different bearings, and the reserve supply is limited only by the size of tank which it is desired to provide. Pumps of almost any type and intermittent in

their action can be used without affecting the supply of oil to the bearings.

(2) Pressure system.—This system is used when pressures are too high for a gravity system or where there is a lack of room, and sometimes for cheapness. It is, however, necessary to have a storage tank in the upper part of which is an air cushion. The oil is discharged into this tank by the pumps before being delivered to the bearings. Without this intermediate pneumatic storage tank, the oil will be delivered spasmodically, depending on the pulsations of the pump, producing vibrations in the whole oiling system, and in addition a large amount of air will be entrained in the oil, which will expand on delivery to the bearing, forming an oil spray which will be carried away by air currents from the rotating machines.

This is especially objectionable in generators as the lubricating oil causes the insulation to deteriorate and dirt collects, clogging up the ventilating ducts, making frequent cleaning both necessary and difficult.

As to the grade of oil to be used in any particular case, it is usually found that the lightest oil that will serve the purpose is the best one, as it will carry away the heat better and the flow is easier to regulate.

Considerable notice has been taken recently of a certain germ treatment for lubricating oils. We have tried this treatment to some extent with rather indifferent success. It is my opinion that there is a wide field for development both in lubricating oils and in methods of lubrication.

Bearings

The building of vertical shaft turbines and generators in increasingly large sizes has necessitated the development of thrust bearings to carry these heavy rotating parts. The large vertical units built ten or twelve years ago were all equipped with high pressure oil thrust bearings. These necessitated very high pressure oil pumps and a great amount of auxiliary equipment which always gave considerable trouble and was expensive to maintain. In recent years there have been three main types of thrust bearings developed, which are in general use, all of which are giving very good results. The Kingsbury, the Gibbs and the General Electric spring bearing. The principle of operation of all of these is the same, but has been worked out along slightly different lines. These thrust bearings give very little trouble in operation. In fact they probably give less trouble than the guide bearings. The principal trouble with the water lubricated lignum-vitae guide bearings used in turbines is in getting a supply of water for lubrication that is free from sand and grit.

Careful balancing of the rotating parts contributes a great deal to the successful operation of guide bearings.

Governors

Turbine governors are among the most reliable and at the same time most misunderstood pieces of equipment in a power plant. Governors if of modern and proper design will regulate speed with a high degree of precision, with load variations usually encountered in supplying the average commercial power, and with a reliability that is exceptional. Their main

function is, of course, to maintain speed within permissible limits under the varying load conditions, by adjusting the gate opening in the turbines to suit the load requirements. It is impracticable to maintain absolutely constant speed under all conditions, and the governors in any individual plant must be adjusted to suit the conditions encountered in that plant, striking a suitable balance between permissible speed variations and pressure rises in the penstock and wheel cases. The flywheel effect or inertia of the system will, of course, assist the governors in taking care of momentary load fluctuations and tend to maintain constant speed throughout the changes, (in other words the inertia of the system tends to resist any sudden changes in speed).

The governors of the individual machines in any plant or in different plants, if operating in parallel, must be capable of adjustment so that the machines will take their proportional part of the load variations. Or in case it is desired for any reason to have one machine or a group of machines operate on base load, (or constant load) and allow the other machines to take the variations, then the governors must permit of the proper adjustments being made to meet this condition of operation.

The cost of maintaining governors is usually very low if of proper design. The moving parts must be kept clean and well lubricated and when once wear has exceeded a few thousandths of an inch on the valves, they must be repaired, if the governor is to function properly. Deferred maintenance on governors results in unreliability and increased wear and tear on the pumping plant supplying the pressure medium, and in poor speed regulation, and may present a very serious hazard to the plant.

Older types of governors operated on a closed system with a pressure on one side of the pump and a vacuum on the other side. This system required a special oil that would not break down under the vacuum. This special oil is expensive and requires to be renewed at frequent intervals, resulting in high operating costs. Manufacturers of modern governors have abandoned the closed system for the open system, and we are at the present time changing over some of the older governors at the O. P. plant from the closed to the open system.

Both oil and water are used as governor fluid, and if the open system is employed the ordinary lubricating oil generally used for bearing lubrication gives good results. If water is used, it must be treated in some way to prevent corrosion. This is usually accomplished by the use of emulsified oil or potassium-bichromate, or some other treatments which render the water non-corrosive. The governor fluid must, of course, be kept free of solid matter, such as dirt and sand, and it is, therefore, necessary to employ filters if water is used.

One of the principal advantages in using water is that it permits the use of centrifugal or turbine pumps, which have lower maintenance cost and longer life than plunger or gear pumps. Centrifugal pumps are not developed to the point where they are generally used for pumping oil at the

high pressures used on governor systems (usually from 150 to 225 lb.). Water is also considerably cheaper than oil.

Both central pumping plants and individual pumps for each governor are employed. In plants having a large number of units, I personally favor the central pumping plant with sufficient spare equipment installed and with automatic features for starting up additional units in case of the failure of one, or the overloading of those in operation.

The central pumping plant tends to cut down the maintenance cost and is more reliable, as there is less liability of losing the pressure in any individual governor which may result in a run-away or poor speed regulation. In the case of a two or three unit plant it is advisable to install individual pumps of sufficient capacity to carry the entire plant and have them all pump into a common pressure header.

Ice Troubles

In severe winter weather ice in one form or another often presents a very serious problem. We have three different formations of ice to contend with in the Niagara River, hard block ice, frazil or slush ice and anchor ice. The hard block ice forms along the river and lake shore in sheltered spots, and when broken up by shifting winds is carried down the river. This form of ice probably causes more trouble in the operation of plants at Niagara than any other form of ice. In exceedingly cold weather, we often have the block ice and frazil to contend with at the same time; in these cases considerable trouble is experienced. The frazil will collect on the ice diverters and along with the block ice forms a solid mass which tends to clog up the water passages. The only effective way to deal with this trouble is by the use of dynamite. From two to six sticks of dynamite placed in a bag of sand and sunk to the proper depth seem to be quite effective. We have never found that permanent structures were damaged by the proper use of high explosives in this way.

Anchor ice forms usually at night in very cold weather on the bottom of the river, then during the day when the sun comes out, it rises from the bottom carrying with it rocks and other rubbish from the river bottom; being thus weighted, it floats low in the water, goes through under the diverters and finds its way into the turbines where it does more or less damage.

During the winter, conditions in the Niagara River make it necessary for all the older plants to operate with the trash racks removed, (we expect that this will not be necessary at the Queenston Plant). With a slush ice, this is not a serious matter, but when hard block ice and anchor ice carrying stones and rubbish gets into the wheels, all sorts of difficulties are to be expected. Most turbines are provided with breaking links so that in case ice or other material jams in the gates and the governors move the gate mechanism, the gates jammed will be freed by the breaking of the links. These breaking links, however, are not always

reliable, and in one case we had a turbine suddenly jam with ice and by a movement of the gates break seventeen out of twenty gate arms besides breaking the links.

In another case two gate links broke, one of the gates turned completely over and wedging with ice and stones acted as a tool would in a large lathe and trimmed off about four or five inches of the runner vanes all round the wheel. The 2½″ solid steel gate shaft was sheared off close to the gate. This turbine was put back into service after replacing the broken gate and cutting off the bent-over vanes, and operated satisfactorily with only a slight decrease in capacity.

Ice trouble in the Otonabee and Trent rivers consists almost entirely of frazil, and I believe that practically all the plants operating on these rivers are affected to a more or less extent at times by this form of ice trouble. This usually occurs early in the winter before the river freezes over and on the occasion of a sudden drop in temperature. The trouble usually disappears after a continued cold spell has caused the different reaches to freeze over.

Different methods of combating this form of ice trouble have been tried out with varying success, such as heating the racks and mechanical rakes, but we have found that in most cases with turbines having comparatively large openings and the wheel settings designed in such a way that the wheel cases can be kept at a slightly higher temperature than the freezing point, serious trouble can usually be averted by watching conditions carefully and pulling the racks before the frazil is running to such an extent as to block them up and shut off the flow of water.

THE ENGINEER IN RELATION TO THE PROBLEM OF FIRE WASTE

By E. P. Heaton, Fire Marshal of Ontario

Before throwing on the screen the slides with which I purpose to illustrate this address, let me define the terms used in the title.

By "Engineering" you will understand even better than I, the application of the term may be very broad, covering professional advice in various specialized directions, as, for example the "Sanitary Engineer," "The Power Engineer" (covering light, heat and power), "The Mechanical Engineer" (covering also electrical conditions), and others that you will readily think of, but I use the term in its generic sense, and interpret it to apply to one who plans or superintends the construction and equipment of buildings to meet the requirements of our modern, complex civilization.

Before I conclude it is possible you may have a vision of an opening for another class, I mean the "Fire Prevention Engineer," for I believe there is a field in such a professional capacity that can be wisely and profitably exercised. As a matter of fact, I am glad that we have in associa-

tion with our office a past president of your Society, and a recent graduate, who are rendering excellent service in the direction in which a Fire Prevention Engineer might profitably use his knowledge and experience.

"Fire Waste" is a subject that has been brought to your attention in your various sections through literature and instruction, and I am not going to waste your time by any extended reference to its enormity, or to its clauses. As a matter of fact, the recent graduate from your Society became associated with us because he was the prize winner in the competition conducted under the auspices of our own office. Suffice it in a word to say that we expect the year 1922 to be the worst one the province has ever experienced in regard to its inexcusable loss by fire, apart altogether from the waste in our natural resources, in the bush, and in the forest. Probably we shall reach the extraordinary total of twenty-two million dollars as the year's fire waste, and it is in consideration of the engineer's relation to that fire waste that I want to say a few words.

The "Problem" centres around two distinct features. Our statistics show that out of about 10,000 fires in the province, costing, as I have said, some twenty-two million dollars, about one hundred fires are directly responsible for one half of the sum total of all the losses. In other words, the big fire carries its own problem.

The second feature is found in the commonly-called "Exposure Fire." In normal years we generally understand that from 15 to 20% of the aggregate fire waste arises from fires in neighboring buildings, or from outside exposures. Owing to the conflagration in Northern Ontario of Oct. 4th, the year 1922 will be specially marked because the ratio of the exposure fires for that year will be between 45 and 50 per cent. We must, however, for obvious reasons, eliminate the Northern Ontario conflagration from consideration and revert to the common experience that about one-fifth of the loss is due to some exposure.

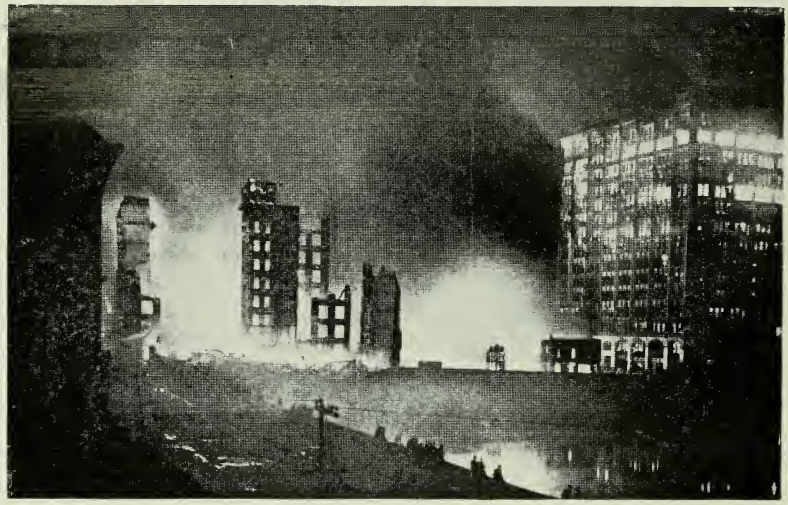
It is with particular regard to the latter feature that I want to throw some slides upon the screen to illustrate and enforce the engineers' relation to a particular feature that will there be brought out, and I will reserve further comment upon the subject until the slides are presented. I may, however, very frankly and candidly admit that the fire waste problem in its broadest sense, and in its restricted application to the exposure fire, can only be solved by the engineer, and to him is not only given the necessity but the opportunity for attacking it and overcoming it. The history of the engineers' work in relation to Fire Prevention is so romantic that I could occupy much longer time than I have at my disposal in picturing it to you, and yet I must briefly bring it to your attention. Some 75 or 80 years ago the cotton mills of New England were burning so frequently that fire insurance upon that class of risk was exceedingly difficult to obtain, and when obtained the high rate charged because of the hazard almost made it prohibitive, consequently the mill owners associated themselves together for the purpose of endeavoring to determine why fires were so frequent, and

how they should be met. It was readily ascertained that very many of the fires came from the picker and carding machines, and at once the engineer's answer was, that being the case, we will segregate these hazards, and put them in separate buildings where, when fire does ensue, the rest of the property will not be endangered, and the fire loss will be comparatively light; and one fundamental requirement to-day of all cotton mills is the isolation of the picker house, and the protection at all events of the carding machines.

At this point Mr. Heaton related Charles Lamb's inimitable and satirical essay in "Roast Pig" and used it as an illustration that may possibly have been drawn from the occurrence of the uniting of the New England cotton mill men to meet the special conditions that were arising in their business. From the gathering together of the mill owners there arose the organization of what is known to-day as the New England Mutual Insurance Companies, the basis of which is engineering service to prevent fires, and Mr. Heaton spoke of their marvellous record and development, featuring the introduction and perfecting of protection by the automatic sprinkler. To demonstrate the efficacy that the automatic sprinkler had reached, there were three distinct periods in the general practice of the insurance companies, the first period running from 1850 to 1875 when automatic sprinklers had just been introduced, but when few installations had been made. In that period of 25 years the loss by fire to the insurance carried was .25c per $100. The next period was from 1876 to 1895 when the automatic sprinkler was becoming more generally recognized, and where many installations were being made. In that period, with four times the amount of insurance at risk the fire loss was less than three times the amount in the preceding period, and the average cost was 18c per $100. The third period was from 1896 to 1921 during which period the senior Mutual Insurance Companies had made a rule of complete and thorough protection of all buildings by the automatic sprinkler. In that period with six times the amount of insurance in force, or, as I may say, six times the liability, the fire loss was just one-third more than it was in the previous period, and the average cost reduced to .04c per $100, a marvellous showing, considering that in that period the amount of insurance was nearly ten billion dollars, due entirely to the work of the Automatic Sprinkler Engineer.

I would like to trace for you the origin and development of the N.F.P.A., who last year celebrated their 25th anniversary, an association of engineers who have throughout given their time, voluntarily, to the preparation of proper standards of engineering in building construction, and in the use of mechanical appliances, and if I had time to dwell upon the intensely interesting history of this Association, it would, I am sure, appeal to you as placing a halo of glory on the heads of the men who have so faithfully, without remuneration, and unstintingly given their time to the work.

I think I may state a truism that you will all accept when I say that the scientific achievements of the last half century have been remarkable in extent and in their benefit to the people, and yet, it is equally true, that in nearly every case the achievement has produced a corresponding fire hazard. Take for example the prevalent use of electricity for light, heat and power, and you all know what hazards have necessarily been met with in the processes and in present day usage. Take again the very common use of the automobile and the motor car with its necessary corollary, in the use of the highly explosive and volatile substance of gasoline. So I might go on and quote other instances, but these are enough to illustrate the statement I have made and also to justify the further statement that the engineer has controlled and safeguarded the hazards as they have been met

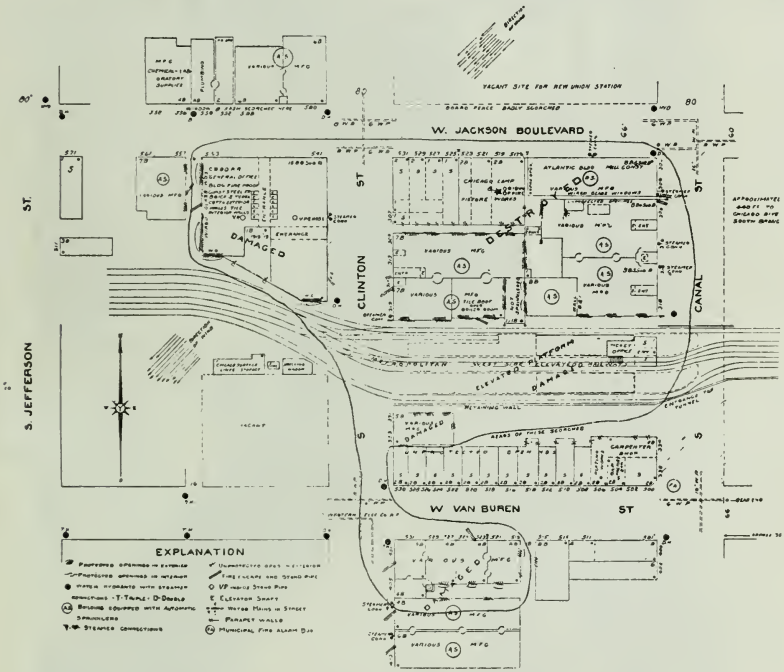


Chicago Fire—March 15, 1922

with, one by one, until it may be fairly said that the involved hazards have been brought into subjection and control, and the fire hazard reduced to a minimum, if not practically eliminated.

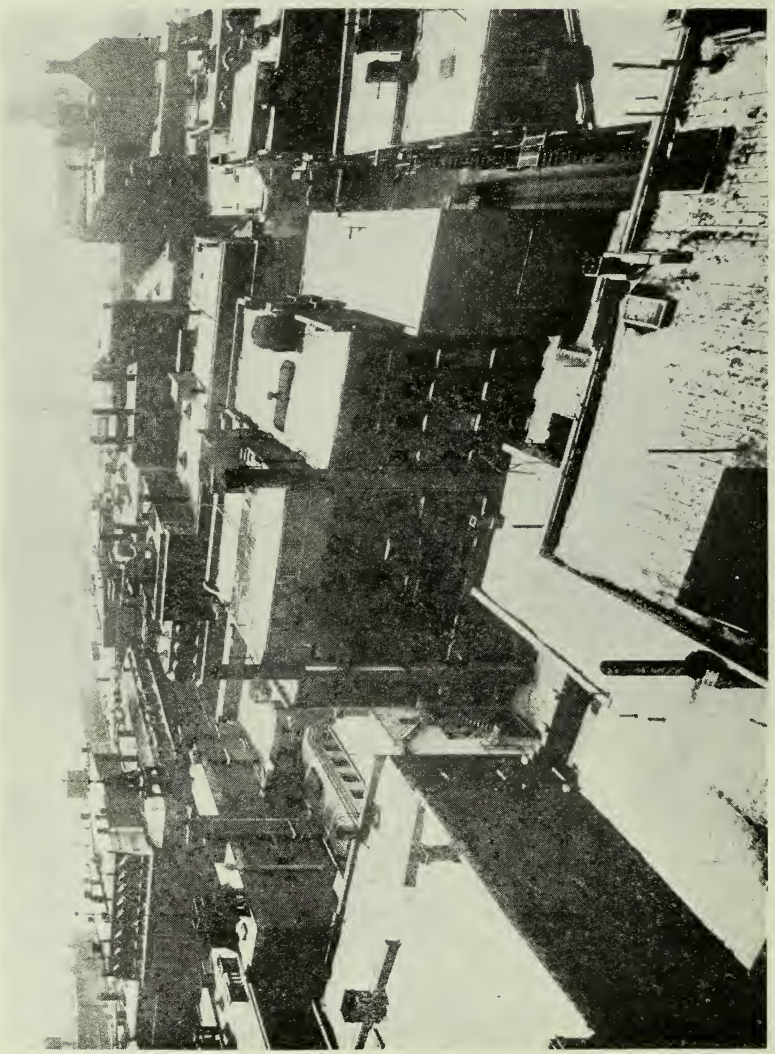
Reverting for a moment to the definitions with which I started, the big fire necessarily arises because of the big plant. These are days of concentration of values, of combination of forces when under one roof must be gathered enormous values. Again, the concentration of population in our urban centres and the enormous increase in land values has necessitated building in the air, and we have the skyscraper. In the course of the last 50 years engineering skill has practically produced the skyscraper, safeguarded in construction and protection to the highest degree, and if on March 14th, 1922, I had asked if a fireproof building had been designed and erected, the answer would have been, "Yes, many of them," and if I had gone to Chicago and looked at the office building of the Chicago,

Burlington and Quincy Railroad, and had asked if that could be taken as a typical illustration, the answer again would have been, "Yes," for if there was one building in Chicago, which, by reason of its construcion and occupation was regarded as a fireproof building, that one was so regarded, but on the 15th March, 1922, the belief had been shattered, for on the early morning of that day this particular building was practically destroyed by fire, at all events, from the 8th storey up, at a loss of considerably over one million dollars, and I now purpose throwing on the screen some pictures taken before, during, and after this fire, that they may bring home to us the fact that we have not yet devised an absolute fireproof building, and that we shall not do so until the control of the fire from without, (the exposure fire) has been brought much nearer to perfection than it now is. In this fire twelve buildings were destroyed with a loss of from five to eight million dollars; seven were of four storeys or less; one was of seven storeys in height; three of eight storeys in height, and one, the particular building already alluded to, the Burlington Building, of fifteen storeys.



Burned Area—Chicago Fire.

Reference to the following diagram will show the area of the fire in question. Nothing is particularly asked to the fact that the Burlington Building, shown on the west side of Clinton Street, fronts on a street 80 ft. wide, and the marvel is, how the fire crossed that street. We can understand how the fire spread from the small old buildings facing on West Jackson Blvd. because of the nature of their occupancy, but it is not



View Showing Danger of Present Situation in Toronto

easy to understand how fire got into the buildings to the south, which were protected as a rule by automatic sprinklers. I want, however, particularly to draw your attention to the number of narrow alleyways having exposed windows on each side, which doubtless afforded a ready spread for the fire.

The entire easterly facade of this building facing Clinton Street had the usual wooden window frames with windows of the ordinary glass. Wired glass windows were introduced in the Lightwell, and also on the west side to take care of the exposure from that side, but in view of the width of Clinton Street no such precaution was taken there. The fire started in one of the small buildings, as is shown on the diagram, at about 12:45 a.m. on the morning of March 15th and by 2:45 a.m. the Burlington Building had also been practically destroyed, as will be shown in the next picture.

Evidence shows that fire did not travel directly to the Burlington Building, but that radiant heat, and it must have been enormous, got through each of the upper storeys from the front to the rear and caused utter destruction on all floors above the 8th.

I have spoken of wired glass because up to this point it has been generally conceded that metal window frames in which wired glass was inserted formed reasonably good protection against any ordinary or even a severe fire loss, but in the case of the Burlington Building it has been shown that where wired glass was introduced the panes were of too large a size and that they, at various points, yielded to the pressure and to the force of the flame from inside, and disintegrated. Without enlarging on the circumstances that are so clearly shown in this picture, it is fitting that I should pause to ask how such a condition as is here represented, can be met and overcome.

I have had a number of pictures taken in the City of Toronto, and will throw them on the screen, where serious conditions of exposure exist, but in this paper there will be only one inserted and that was taken from my office window.

If you will notice the narrow alleyways, the exposing rear windows on nearly every building, you will see a spot in Toronto where there is an easy path for a spreading fire. It was just such conditions as this that caused the last Toronto conflagration, and not only in this case, but in many others, are we liable to have a recurrence because of the exposure from unprotected windows and doors, and here you have the problem of the engineer in relation to the fire waste, which I must leave with you for thought and consideration.

In closing may I mention that on the facade of the great Union Depot at Washington, D. C., there is a panel dedicated to the god of fire, upon which there has been inscribed by a well known artist, this motto:

"Greatest of discoveries enabling man to live in various climates, use many foods, and compel the forces of nature to do his work."

Yes, fire is a good servant but a bad master.

PROBLEMS OF TOWN PLANNING*

By Horace L. Seymour, C. E. (Tor.)

"Town Planning is the scientific and orderly disposition of land and buildings in use and development with a view to obviating congestion and securing economic and social efficiency, health and well being, in urban and rural communities."—Definition approved by Town Planning Institute of Canada.

"Make no little plans; they have no magic to stir men's blood and probably themselves will never be realized. Make big plans; aim high in hope and work realizing that a noble logical diagram once rendered can never die but long after we are gone will be a living thing asserting itself with ever growing insistency. Remember that our sons and grandsons are going to do things that would stagger us. Let your watchword be order and your beacon beauty."—Daniel H. Burnham.

Every municipal engineer should understand the principles of town planning and should be more or less familiar with its technique. For a successful civic development the city engineer should be a city planner.

History and Legislation

Town planning has been described as both a science and an art. As an art it has been practiced for centuries, as a science, merely with the century. Raymond Unwin tells us that the first historic case of town planning is that of the town of Kahun, in Egypt, where 3,000 years B. C. the town was built to provide for the needs of workers on the pyramids being constructed in that vicinity. Since that early date many examples might be cited of the practice of the art of town planning and would include the names of many ancient and modern towns and cities.

One of the evidences that town planning was becoming not merely an art but also a science is found in legislation in the sixties of the last century in such countries as Italy, Sweden and Prussia. Some of this legislation dealt largely with the matter of expropriation of land by which a community could provide for street widenings and extensions or other changes of advantage to the community. In most countries the power of the state in this regard is now generally recognized and upheld by law, but, up until a few years ago at least, in the city of Vienna for example, no property could be taken by the city without the approval of the individual. The providing of legislation, therefore, in the early period of the latter part of the 19th century was a considerable advance and permitted town planning to be treated from a more scientific standpoint than in the past. Most countries in the world have certain measures of town planning legislation either in force or being considered.

* Based on a series of lectures delivered to Fourth Year students in the Municipal Engineering Option, Easter Term, 1923.

Canada has been more or less influenced from two sources, these being the United States and Great Britain. In the Old Country town planning has been regarded largely from the health and housing standpoint and the British housing and Town Planning Act of 1909 grew out of previous health legislation. It did not provide for expensive corrective measures in the areas already developed, but it did endeavour to prevent the making of mistakes in new or only partly developed areas surrounding older development. The amended Act of 1919 gave town planning a wider scope and made the preparation of certain town planning schemes compulsory.

American Developments

In the United States, Washington, the capital city, is a happy example of the earlier town planning art. A certain phase of town planning received a great impetus at the Chicago World's Fair in 1893. Here the wonders that might be accomplished through studying groupings of buildings were made apparent. There arose the idea of the civic centre, which has been of value in the development of the United States. It has also been detrimental in some instances to the idea of town planning in that it introduced an almost prohibitive expense to the average developed town in taking the necessary corrective measures to provide for a suitable civic centre.

Since then there has been developed very widely the idea of zoning, which is an important part of city or town planning and which, as opposed to the civic centre, is comparatively inexpensive to put into operation. In 1908, Alameda, in California, put into effect an ordinance under which the use and other characteristics of a building could be controlled. In 1916, New York, the largest city in the United States, put into effect an ordinance and since then hundreds of cities have followed the example or are considering doing so. In our understanding and outlook of city planning we are undoubtedly influenced by what is happening in the United States. In all but two provinces in Canada there is legislation of more or less town planning value. In such provinces, as a rule, the acts have followed largely the British Acts of 1909. In Ontario there is a Planning and Development Act which is an amendment of the Cities and Suburbs Plans Act of 1912, which was enacted largely through the efforts of the City Guild. There are numerous other Ontario Acts, but particularly the Municipal Act which contains town planning provisions applicable, as a rule, through municipal by-laws.

Frequently settlement preceded surveys, while now surveys, with few exceptions, precede settlement. Both the methods and the inaccuracy of early surveys were shown to have an effect on the present problems of town planning. Some of these effects are jogged and irregular streets; difficulties of opening up new streets through badly surveyed areas and difficulties in planning, due to the fact that original surveys were generally

made without regard to topography. It was shown that in some early surveys the areas were laid out by settlers themselves. In New Brunswick and Nova Scotia it was difficult and often impossible to find original survey monuments. The original surveys of Prince Edward Island, although magnetic, were well executed.

An interesting example of early radical planning in the Province of Quebec was illustrated at Charlebourg and vicinity, near the City of Quebec. While under French domination, there was an endeavour to provide, what has been so often mentioned, as very desirable, a village or centre with farms radiating therefrom. As a rule, however, we find the early farms of great length have been divided into narrow frontages, especially those on the St. Lawrence River. Townships now surveyed in that province are ten miles square with boundaries, north, south, east and west. The principle of long, narrow farms is still continued as having the advantage of close settlement. The result claimed is, that in Quebec, people do not leave the farms as in some provinces, where the method of survey has separated the settlers to a greater extent.

In Ontario there have been various systems and also a lack of system in township surveys. In the early days farms were granted or conceded along rivers or lakes. As settlement was forced further back from such main topographical features, the best means of transport in those days, further ranges of "concessions" were surveyed. The more recent system of surveys in Ontario have been the six mile and the nine mile townships.

Tribute should be paid to the manner in which township surveys are now carried out by the Dominion Government in Western provinces. Suggestions have been made for changes in the method of survey, which would make them as desirable for settlement as they are now excellent from a geometrical standpoint. In British Columbia it was shown that in the more mountainous country, lands were staked out very similar to the staking out of mineral claims.

In Western Canada out of over 200,000,000 acres of land surveyed, there was a few years ago but 20,000,000 acres under crop, while within twenty miles of a railway there were 15,000,000 acres of vacant land.

Zoning

The term "zoning" is derived from the practices of the walled cities of Europe where the existence of arbitrary authority made it possible to carry out stringent regulations with respect to the character of the different parts of the city, various areas being actually in the form of a zone. In America, zoning might better be termed "districting or delimiting" as the areas to be regulated are not necessarily zonular in shape.

Zoning has been defined as public control of private property in the interest of the health and welfare of the people and as the determination of the character and intensity of the use of land, and more specifically as the

control under community power of (a) the height of buildings and (b) the percentage of area of lots that may be covered with buildings and (c) the use to which buildings may be put on private property.

The advantages that have been ascribed to zoning include the following: (1) Permanent development of the area concerned; (2) provision of adequate light, air and sanitary arrangements; (3) orderly growth of the city; (4) prevention of undue congestion; (5) stability of property values; (6) saving in the cost of construction of service utilities.

In a restricted sense the term "Town Planning" is generally considered to mean the public control of what is, or what is to become public property. As applied to cities it has been considered to include, for example: The street lay-out; sewerage system, water supply; transit and transportation system; port and terminal facilities; park and recreational system; location of public buildings. But public property in the average city or municipality constitutes but one-third of the area in street, parks, etc. From over one-half to two-thirds is private property. Zoning is that part of town planning which has particular reference to the public control of private property.

Advantage of Zoning

The advantage of zoning is generally considered or it might be said is popularly considered, to be that of the protection of residential areas. There are advantages easily recognized by all those who enjoy home life. It is easy to fall into the error of unduly emphasizing this phase—the protection of the home being a popular appeal. While this is undoubtedly one of the aims of the town planner, he has other important and fundamental aims—the protection of the factory and factory sites; the protection of the business and business sites. The answer to "Why is a city?" or "Why is a town?" must be in general a commercial or industrial one. First of all there must be considered the location of industries and the protection of industrial sites. Then the location of business and the protection of business sites and finally the location of residences and their protection from the unnecessary intrusion of industries or business. Every zoning scheme must include the provision of an adequate transportation system to link these areas of various uses together. Scientific zoning means co-ordination not segregation.

Planning for Sunlight

Various disease bacteria, such as typhoid, tuberculosis, etc., which can exist even for years in dark places, succumb to direct sunlight, of from a few minutes to an hour. Of particular importance in this regard are the matters of orientation of houses, disposition of rooms and the location of windows and verandahs.

For the free standing house, charts and diagrams may be made to show that the orientation most desired is that when the faces of buildings are not square with the cardinal points but at an angle of 45 deg. therewith. For streets in residential areas, the desirable direction is generally that of north-east, south-west and north-west, south-east, especially if blocks are square and not long and narrow. With high buildings on long, narrow blocks, the north and south street is shown to be the best street for main development. Ideally planned, the sunlit city would have a gridiron of long narrow blocks running north and south for the business section, surrounded with a checkerboard of residential streets radiating diagonally from a central development.

For the provision of sunlight as well as for other important reasons, the general rule is that the height of buildings should not exceed the width of the street or the distance between buildings.

Practical Examples

A parallel may be drawn between the city of Halifax and the town of Haileybury in regard to the physical location and the disasters which called for the solution of problems for rehabilitation. These offered an unusual opportunity for replanning.

In the Halifax disaster of 1917, funds were made available for, and sufficient powers vested in the Halifax Relief Commission, so that all residents suffering in the disaster were reimbursed for losses and were provided with temporary shelter in the form of rows of frame houses in various parts of the city, but *not* in the area which was being replanned for future occupation. This was a comparatively easy solution of the problem, but such treatment was not possible in Haileybury. No immediate fund was available to meet private losses, but lumber for temporary shelter (a "shack" 16 by 20 ft.) was being provided by the Relief Organization. It was necessary and reasonably so, that an owner should be allowed immediately to erect a shelter on his own lot. Building permits issued however, have been almost entirely for temporary buildings to be renewed or made to conform to building by-laws in force on the 30th October, 1923. In many cases the owners, who must keep their temporary buildings in ordinary cases at least 20 ft. back from the street, are putting them back further to be used as kitchens when the permanent house of the future is erected.

In considering the problems of planning in Haileybury, the relation of Haileybury and its urban zone, and its relation to adjacent towns with their urban zones, must be understood. The lack of proper topographical maps hampered the work to no small extent. Council by-laws provided for fire areas and the segregation of residential from busniess, warehouse and factory sites.

Old School

1891 — 1901

"School!!!" And 800 *enthusiastic* engineers rend the heavens with a "Toike Oike" that leaves in oblivion more intelligible yells.

"School!!!" And 800 *excited* engineers are on their toes, thirsting for Meds' blood and Arts' gore.

"School!!!" And 800 *enraptured* engineers cheer on that loyal team to victory.

"School!!!" And 800 *enthused* engineers uphold the honor of the Blue and White.

"School!!!" And 8,000 *eminent* engineers from every clime, country and calling, look back with love and loyalty upon that "Old Red School House."

What is this intangible yet intrinsic and dynamic feeling that lays hold upon our innermost beings by those two words "School Spirit?" What is the reason for this friendship and fellowship, this inherent affection so symbolic of "School" men, graduate and undergraduate? Does it not find its origin 'way back in the olden days; 'way back in the years that have produced some of the most illustrious engineers and leaders in our Canada and other nations? We are proud to uphold the traditions, the ideals and loyalty to our Alma Mater, handed down to us from our engineering forefathers. We cherish the memories and the successes of those men who not only brought into existence this "School" and "School Spirit," but who have gone out into the world and laid the foundations for that practical science upon which we aspiring students hope to build.

Now let us turn back to those pioneer days. Let us have a squint at some of those prominent engineers at School. From our humble and inexperienced position we look with awe upon their successes and accomplishments and we often wonder to ourselves just what they were like in their youthful days. Did they participate in some of our spirited but foolish antics? Were they always getting into trouble with other faculties, the S. A. C. and the "powers that be"? Did they experience the same reluctance to arise for those nine-o'clock lectures? Did their thirst for knowledge overcome that welcome for the minute hand's arrival at the hour?

As we were saying—from our humble and inexperienced position we are inclined to wonder. Let us see:

A. T. Laing—'92

When the class of '92 knocked at the door of the little "Red School House" for admission there were twenty-eight in all, constituting the largest class up to that date. The ever-watchful and faithful servant "Prof." Graham was on hand to extend a word of welcome, the usual salutation be-

ing, "Well, young man, what are you doing around here?" delivered in such stern tones and in such an authoritative manner that the timorous freshman felt certain on the outset that no liberties could be taken with the caretaker. It was soon realized, however, that he was not only the faithful servant but also a good-hearted friend of the students. He was a living part of the old school and the students from year to year for many years gave tokens of their appreciation of his character and many kindnesses. His old friends will be glad to know he still enjoys life in retirement.

Matriculation, at this time, was not a prerequisite to admission, but the applicant was supposed to have a certificate from a high school master of good character and a statement of the advanced work he had covered. Failing this, he was asked to have a quiet talk with Principal Galbraith, than which some declared they would have preferred the matriculation examination, but it resulted usually that none who were really in earnest were turned away.

The class comprised representatives from nearly every walk in life, and it was claimed by one member that he could discern from the vernacular the environment from which each had come; the son of the soil drew his illustrations from farm life and so for the son of the tailor, the merchant, the physician, and we may be pardoned if we omit here the language of the lads from the parsonage. But there was one about whom there could be no conjecture in this regard, the seafarer. The deep sonorous voice of Virgil Marani was like the sound of many waters, at times thundering and tempestuous. His language at times was, perhaps, more forceful than elegant, but it was direct and unambiguous, and was profusely punctuated with the phraseology of the sailor. His spellbinding stories of life at sea made him very popular. It is no reflection on students of the present day to say that seriousness and definiteness of purpose was, perhaps, more in evidence than at present, due no doubt to the fact that the average age at entrance was about 22 years as compared with 19 years at present.

There was no rendezvous for students, no supply department by the Engineering Society and the library of the Society, still in its infancy, was cradled in a small room adjoining the furnace room in the basement. Having outgrown this space, room was provided on the top floor and the students were assigned the task of moving. It consisted of about one trip for each man carrying one book. It is interesting to note in passing that the only smoking then was indulged in by the caretaker, who confined his operations to the furnace room and took great pains to see that the furnace was an efficient smoke consumer.

An interesting feature of each session was the opening meeting of the Engineering Society which took the form of an experience meeting, the students giving an account of their summer's work. On one occasion a student who had a reputation for a disregard for personal appearance and an

aversion to bathing, related how he had had to chain through water well above the waist. Some doubt was expressed as to his statement, but a friend vouched for him, stating that he had seen the high-water mark.

One event which overshadowed all others in magnitude and importance was the disastrous fire of February, 1890, which destroyed the east wing and the greater portion of the front of the University. It was a staggering loss, including as it did many valuable records, an excellent library, many volumes of which could not be replaced, as well as a costly building. It was on a night set apart for a Conversazione, which was an annual affair and was the one and only big event of the session—how different now. The School was assigned a room for display and this was suitably fitted up, representing in one corner a surveyor's camp and about were instruments, chains, pickets, etc. The walls were decorated with many *beautiful* and *valuable* drawings of the first year. All was a total loss and the poor students received no consideration except that no one was plucked in drawing that year. Up to this time the rooms of the University were not equipped even with gas fixtures and for special occasions lamps had to be borrowed and mounted on improvised chandeliers. The origin of the fire was due to the carelessness of a servant who, while placing some of the lighted lamps, upset one amongst a lot of others and all burst into flame. The point at which the accident happened made immediate extinction with the means available impossible. The facilities for fighting fires from without were entirely inadequate and before the fire could be controlled the building was in ruins.

The next noteworthy event was the construction of the southerly portion of the present Engineering building to meet the growing demands for space. The building was completed during 1891 and to celebrate the occasion a formal opening was held January, 1892. It was an auspicious occasion. The whole building with the newly-equipped laboratories in Mechanics of Materials, Hydraulics, Electricity and Thermodynamics, etc., were thrown open to visitors and the budding engineers of the graduating class shone forth in great splendor as, arrayed in blue jean overalls, they operated the machines which they understood little better than did the spectators.

The new building, on account of its outlines, was not considered a thing of beauty and went under the name of Galbraith's Factory. At a University convocation held in the present first year drafting room in 1891, the then chancellor, The Hon. Edward Blake, congratulated Principal Galbraith on the expansion, and particularly on the establishing of a department of architecture, stating that there could not be a better place for such a school. In the University building was something to inspire and to be emulated in design, while in the new school building was something to be avoided.

During the years to which this brief sketch applies, there was a growing demand on the part of the students for recognition other than that set forth in the graduation diploma. It was urged upon the Faculty Council that

there should be a degree established. The council was sympathetic but it did not have degree-conferring power. An arrangement, however, for such recognition was brought about by the council with the senate of the University whereby in January, 1892, the degree of Bachelor of Applied Science (B.A.Sc.) was established. The requirements of a candidate for this being that he should hold the diploma of the School of Practical Science or be of fourth year standing in the honor department of Chemistry and Mineralogy of the University of Toronto. The session 1892-93 saw the first class registered in what was called the post graduate course leading to the B.A.Sc. degree. The class consisted of eleven men, eight of whom were from the class of '92 and three from previous years, and all were successful.

One cannot close without reference to the two outstanding figures, the late Dean Galbraith and his intimate friend and colleague, the late Dean Ellis, men of widely different characteristics but in a remarkable way the one the complement of the other, men of surpassing ability and attainments in their respective fields and who found at the same time an abiding place in the esteem and affection of all students. Their aims and objects were to build up an institution worthy of the name and to aid all who sought its benefits, and their achievements in these respects are at once a challenge as well as an inspiration to all who follow. Their memories are cherished by all who came under their influence.

"When great men die,
For years beyond their ken
The light they leave behind them lies
Along the paths of men."

A. T. Laing.

C. E. Langley—'92

My first recollections of the "Old School" began with the curiosity excited by that wind gauge affair which used to spin and glitter above the skyline, and which could be seen from the dog-pond where, as kids, we used to sail our toy boats. Perhaps there was a subconscious determination even then, to learn, some day, what went on inside those red walls.

That "dog-pond" was then a picturesque institution in Queen's Park—Toronto's Serpentine, in fact. A little lake formed by a high dam across the creek at the eastern entrance to the campus; and so, just south of where Hart House now is. "Musk Rat" I think the creek was called, but this may be checked by a reference to our freshman's survey drawings of '88; for as fate would have it, this very spot, drained by scientific vandals, was chosen for us surely out of pure cussedness like lots of other things because hard to get right, as a fitting place for wee Davie Burns to put us over the bumps with the instruments.

About this time it seems to have been realized to some extent at least, that the fine Arts had, as a matter of concern for the University, been neglected, and in '89 the Architectural course was started. C. H. C. Wright for staff; yours truly for class. It is a matter of pride with my mother-in-law to show the newspaper clipping indicating my standing: No. 1 in every Architectural subject. This course has gone steadily forward, as we all know, until now it is to be reckoned with and a justified cause for pride. Naturally it can yet go far, and besides furnishing professional education, be a great factor in the necessary cultivation of, and general appreciation in fine Arts, by people who call themselves well educated.

The fine Arts of a nation might well form a better skeleton than Kings and dates on which to hang history: and general cultivation and appreciation is necessary if Canadian Art is to take its proper place. It is food for thought that so few, even leaders, have any knowledge of the eternal fitness of things in matters of beauty. Perhaps, some day, it will not be optional to remain ignorant on these things.

I seem to have got away from the few little recollections I had intended to put down, and now I have taken up much more space than you wish me to occupy.

I might have mentioned the distinction S. P. S. had in the fact that it was our assistant janitor, "Game" Goodwin, who dropped the tray of oil lamps in the East Wing and so thoroughly set fire to University College the night of the Conversat. We did our best to kill "Game" at Wellesley School when boys, but he was destined to a higher end.

There was a splendid demonstration of cultured boneheadedness at the fire, suggesting "presence of mind" as a compulsory study: the recklessness with which the mattresses and pillows were carried down stairs from the residence, and the care exercised in hurling carefully articulated skeletons from the museum windows, was truly beautiful in a cubist way of speaking.

Another regrettable incident: when the sodium exploded and Dr. Pyke's eye was hurt. We didn't realize that at the time, and were only vastly entertained at Jo Jo Bonstead, his assistant, who seemed mortified, knowing that sodium shouldn't kick up in that way, properly handled.

C. E. Langley.

Walter J. Francis—'93

In order to appreciate this little story of my years at the School, you will have to move your mind back thirty-four years—a rather long period to look forward to but very short in retrospection—for I entered the School in 1889. In those days things were different from what we have them now. That was before the electric street cars. Horse-cars and stage

coaches ran on Yonge Street then, and I remember the stage coaches used to be parked in front of a tavern on Yonge Street just opposite where the Simpson store now stands.

My rector at the old Grammar School had told me of the glories of architecture, and I went to the School to look for an architectural course. There was none. I was enrolled with the Civil Engineers of '92, and I took some extra lectures to help fit me for the architectural profession.

Varsity was very different from what it is now. The Main Building stood in solitary majesty beside the beautiful campus which was the pride of all Toronto. It was the only important building then standing of the whole University group. Taddle Creek meandered down the valley which is now usurped by Hart House, the Library, the Medical Buildings and the Biological Building. The School was a lonely red brick building nestled beneath the great elm trees still standing and next to the high garden fence of the Observatory, in which grounds the Weather Man—the same old Weather Man, but he was not Sir Frederick Stupart then—had all his mysterious little structures used in making the weather. The main building of the Observatory stood in what is now the middle of the street leading from College Street up to the Main Building. It was moved and re-erected stone by stone on the site it now occupies near the Main Building. I do not remember what was on the other side of the School building, excepting that there was some broken ground and Wycliffe College stood facing on College Street. The School building as we knew it was that part which now forms the north wing of the present red brick building. The front door faced on the campus. Above its lintel were engraved mystic characters forming words. Perhaps you have never appreciated that doorway. While it is not so beautiful as many of the other University portals, it is, nevertheless, beautiful because of the memories which surround it. There was one wing of the Biological Building completed—that part with the semi-circular end on it. The little red brick Y. M. C. A. building, with its single polished granite column at the entrance, occupied a prominent place at the front entrance to the grounds from College Street.

The old School building, small as it was, was more than sufficient for the needs of the school, the activities of which centred on the middle floor. There were three professors—Professor Galbraith, Professor Ellis and Professor Chapman. Mr. L. B. Stewart was lecturer in surveying and there were two other junior members of the staff. Mr. Stewart was also the secretary.

I recall very clearly that R. A. Ross, of Woodstock, now Dr. R. A. Ross, of Montreal, was the only student in mechanical and electrical engineering. He used to take a number of his lectures all alone in Professor Galbraith's room. When he came out he looked so wise that we all wondered whether there was room for another idea in him. Up to this time there had been only about fifty or sixty graduates of the School, and we had all heard of Morris and Tye and Duggan and Thompson and

Haultain, but few had the opportunity of making their acquaintance personally. C. H. Mitchell, now Brigadier-General Mitchell, the Dean, was a member of the class of '92. He knew the ways of Varsity better than the rest of us because of his having been a year or two in Arts before he entered Engineering, and we all appreciated his superior knowledge and experience. The Engineering Society was flourishing then in the fourth year of its existence. It was founded two years before the Canadian Society of Civil Engineers, and H. E. T. Haultain was the first student president. Before his time Professor Galbraith occupied the presidency of the Society.

All these things were before the days when School men counted on the Varsity multitude. We took a lot of our lectures in the Main Building—Sir Daniel Wilson was president then—and sometimes we had lectures from the University professors who came to the old building. John A. McGowan, now Professor McGowan, gave us our lectures in trigonometry, while Professor Alfred Baker, his senior, delivered the lectures on calculus.

Probably the outstanding event of that first year was the disastrous fire in the Main Building, when the greater part of the front and the whole of the east wing were completely gutted. During the afternoon I had been helping with the decorations for the Conversazione to be held in the evening. On my way home at dusk I saw the reflection of a great conflagration, not dreaming at the moment that it could be the old building of which we were all so proud. It seems an oil lamp had been upset and had ignited some of the decorations. The east wing, by the way, used to be Convocation Hall, with the basement of which sulphurous fumes and muffled groans of the freshmen used to be associated.

I was deeply impressed with the first Literary Society election I attended. It was in a hall downtown—I forget where. The most important duty that any student had was to cast his vote, and I remember I succeeded in exercising my franchise at about three in the morning, after which I returned home sore but satisfied, minus a coat sleeve and most of my buttons.

The glamour of architecture faded when I learned the prospective wages, and having obtained a position on the construction of the Toronto Belt Line Railway during the vacation, I thought I developed a liking for engineering, so in the autumn of 1890 I returned and entered regularly as a freshman in Civil Engineering. That was the year when the remainder of the old red school house was put into commission. It had been finished during the vacation and we took possession in October. Professor A. P. Coleman took the place of Professor Chapman, and Professor Galbraith and Professor Ellis continued as before. Mr. C. H. C. Wright and Mr. T. R. Rosebrugh, both of whom have since been elevated to the professoriate, were added to the staff, and Mr. Wright had charge of the newly-formed architectural course. The first year of the '93 class began the crowding habit that became so marked at the old School twenty years later. But the years succeeding '93 were much smaller, and, if I remember well,

'93 was the largest year of all until the graduates of 1900 or 1901 were turned into the world. We had with us J. M. R. Fairbairn, now Dr. Fairbairn, the chief engineer of the Canadian Pacific Railway, and L. C. Charlesworth, now Deputy Minister of Public Works of Alberta, and N. M. Lash, now chief engineer of the Bell Telephone Company of Canada. We also had Frank N. Speller, the great authority on the manufacture of steel tubes, as well as many others I could mention. Our ways were pleasant ways, and there is not one who does not smile to-day when he thinks how Nor. Lash could walk on all fours, and how Virgil G. F. Marani was always "the life of the party." Then, just as for twenty or more years to follow, as regularly as the evening came we heard the familiar voice of Prof. Graham ring out "Five o'clock, Gentlemen!" and we left the rooms reluctantly.

In speaking for myself, I formed associations and friendships in those times which have become more firmly cemented as the years have rolled by. There are five of us—all old Toronto boys—in Montreal, where we have been for years. Although relatively large in numbers, our professors knew us individually. The culture and manly charm of Dr. Coleman were appreciated by all, and when Dr. Galbraith and Dr. Ellis graduated into the Greater University I felt that I had indeed lost two very close friends.

Many of the old-time students I have mentioned are known throughout the length and breadth of the land and have attained positions of importance in the community. The profession has not failed to recognize their worth and interest, for Mr. Tye, Mr. Duggan, Mr. Ross and Mr. Fairbairn have all been honored with the presidency of the body which represents the engineering profession in Canada—the Engineering Institute.

I like to go back to the old place—indeed, I do go back every time I can find a reason, or, more properly speaking, an excuse to do so. It is most refreshing to talk for a while with those who were there when I was, and it is very pleasant to recall old times and still more pleasant to renew old friendships.

Yours very truly,

WALTER J. FRANCIS.

L. C. Charlesworth—'93

The freshmen class of the fall of 1890 when I started in at the Old "School" was, I believe, much the largest in the history of the school up to that time, and was so much stronger numerically than the second year that we practically all escaped the "hazing" that according to time-honored traditions we should otherwise have received.

It was, I believe, the first year that the enlarged building was put into use. Prior to that time what was the north wing of the new building had

comprised the whole "School." The new first year draughting room, which had probably been designed to take care of the expected increases for some years to come, was well filled by the large freshman class.

That, too, was I think the year that C. H. C. Wright, who had graduated with high honors a few years previously, joined the staff. The other members of the staff were "Johnny," "Louis B.," "Doc. Ellis," "Chappie," "Rosebrugh," "Duff," "Cæsar Marani" and "Five-o'clock-gentlemen Graham." Dr. Coleman came a year or so later.

Among the students in the second year was the present Dean, "Charlie" Mitchell, and he was, I think, one of the first outside of our own class with whom I became acquainted. This acquaintance was the result of a transaction which was very satisfactory to me and probably just as much so to him. By it I acquired some second-hand text books at reduced prices. Deacon and Dunbar were also there and the boxing bouts, or rather slugging matches, between these two heavy weights certainly provided lots of entertainment. C. H. C. Wright was a fine football player (association) and the School shone in that line, Alex. Goldie and Kit Forrester of our year being prominent players. One of the best-known figures of our year was Virgil Marani, a brother of Cæsar's. Virgil, who had spent much of his life at sea and held, according to report, first officer's papers for sailing vessels and second officer's papers for steam vessels, had come in the previous year as a special student and then started as a regular student in the fall of '90. He was a striking looking curly-haired Italian with the devil in his eye, and though not tall was built like a bull and was just as strong as one. Virgil could talk at any time on any subject and loved to do it, and as he had a wonderful fund of experience and had travelled all over the world his tales were a never-ending source of entertainment. As he himself said, the more people there were observing him the happier he was. When things grew dull in the draughting room Virgil would be given a subject and called upon for an impromptu speech which you may be sure was never dull but which was suddenly interrupted and wound up with the remark, "Oh, my God! There's Johnny!" Whenever there were any grievances to take up with any of the staff Virgil was the man deputed for the job and his talk could charm fairies any time.

Literary society elections were at that time a matter of brute strength. The party strong enough to get possession of the polling place permitted none but its own supporters to vote. Needless to say, Virgil's assistance was eagerly sought by both parties each year and when stripped and vaselined for action he was a vicious looking object to tackle and helped materially to win elections. He was a prominent member of the Lit for that one evening each year.

Other members of the class were Jack Fairbairn, Frank Speller, Jim Robertson and Nor Lash, who when a lecturer happened to be late used to entertain us, and probably could do so still, by walking on all fours with

his palms flat on the ground and his knees and elbows stiff. There was also Walter Francis. Francis was a beautiful draughtsman, and those being days of depression and of difficulty in getting jobs, his draughting generally gave him an entering wedge ahead of the other fellow. He has since attained an eminent position in the engineering profession and whenever I hear a student or young engineer expressing the opinion that time spent in acquiring skill in draughting is wasted and that "once a draughtsman always a draughtsman," I try to change his viewpoint. Of course, outside of the draughting altogether, Francis could deliver the goods.

For physics we had to go over to Professor Loudon in the Arts Building. The physics lectures were attended also by certain Meds. Our large class crowded the lecture room so that a number usually had to go without seats and a small sized war usually occurred between S. P. S. and Meds accordingly. In spite of this, S. P. S. and Meds would unite against Arts any time. The same condition of crowding existed in some lectures taken jointly by Arts and Meds and on one occasion an S. O. S. call came over to us from the Meds asking for assistance in a big fight over at the Arts Building. We all turned out and it certainly was a real scrap, involving practically every student in the University. Being finally driven from the lecture room and corridors by the fire hose, we repaired to the campus and kept the row up all day. Not a lecture was attended by anyone. Next morning all were surprised on arrival to see the campus and buildings guarded by a considerable squad of city police. Had this not occurred the fight would probably have been a thing of the past, but the sight of the police was sufficient to start a real row. All hands united to round up the "bulls" who soon took refuge in one of the small white brick houses which then stood near the southwest corner of the campus. The crowd surrounded the house leaving an open space in front in which Virgil stood and addressed them and the police in turn. He had a beautiful and varied vocabulary for such an occasion. What the outcome would have been it is hard to say had not Sir Daniel Wilson, the President, who was then in poor health, but intensely popular with the students, appeared on the scene. He had been summoned from home, where he was really ill, as a last resort. In a short address he appealed to us to disperse and we gave three cheers for Sir Daniel and went back to lectures while the police slid out the back door and went home.

These and similar occurrences of seemingly no importance are the things that remain as evergreens in my memory of those days and while I fear that they may prove too trivial for your own use, I send this along for what it is worth.

L. C. Charlesworth,

Deputy Minister Public Works, Edmonton, Alberta.

H. V. Haight—'96

My time at the old S. P. S. was from the fall of 1893 to the spring of 1897. Attendance was at a low point, about 125 in the whole school, I think, but the quality I think was high, as it included R. W. Angus and J. W. Bain, who were classmates of mine, and C. H. Mitchell, who was a year or two ahead. In Arts I remember seeing several times W. L. M. King, as he was then called, and I believe Mr. Meighen was also at Varsity, though I don't recall hearing of him at the time.

My most distinct recollection of C. H. Mitchell was his paper before the Engineering Society on the subject of Flying. Even then his explanation of soaring flight seemed to me to lack something, and I see now that it did not recognize the need of an upward component in the wind to render possible sustained gliding or soaring flight. Of course, at that time man had never flown.

Of W. L. M. King I remember his announcing at the sports, for which his great voice was well adapted. One theatre night, when the "Gods" at the old Grand was filled with us, King sang a solo between acts, up there in the "Gods." It was fearfully hot and King was minus coat, vest, collar and tie. A few days later I heard him sing at a concert in Massey Music Hall, very correctly attired in evening clothes.

In my fourth year about half a dozen of us chose French for our language option, and were taught by "Johnny" Galbraith himself in his big office. He knew French well, and he knew how to teach, though his methods were original, and we did really learn some French, but had considerable fun in the process. We had been over some article in the "Competes Rendus" pretty thoroughly till we knew both the French and the English by heart. Prof. Galbraith read a sentence in French and asked Bert Angus to translate. Bert had been talking to Charlie Macbeth and hadn't heard the sentence, but glibly gave the English of a sentence about a paragraph farther on. Prof. Galbraith said, "Oh, Mr. Angus, we haven't come to that yet." Prof. Galbraith's assignment of home work was to tell us to take any French article we liked, translate it into English and bring the translation. He read the translation to make sure it wasn't "Frenchy" but didn't compare it with the French. This seemed to leave a loophole, so once, I think I was the guilty one to suggest the experiment, we all decided to copy out some English article that never had been in French. It worked. Bert Angus was commended for his very free translation.

It was interesting to be at the beginning of some scientific developments. I saw a demonstration of wireless waves, Hertz waves I think they were called, when they were transmitted across the lecture room.

Some of the first calcium carbide that Wilson made was sent over for a meeting of the Engineering Society and we saw a demonstration of the acetylene light.

When the news of the discovery of X-Rays was cabled from Germany some experiments were immediately made at the S. P. S. and I had one of the early X-Ray photos.

Yours truly,

H. V. HAIGHT.

E. H. Darling—'98

In reply to your favors of the 4th and 18th inst., I do not know that I have much to contribute in the way of reminiscences for the year '98.

The freshman year of '95 was one of the smallest since the School began to grow. Not more than thirty-six made a start, and of those who completed their three-years' course I do not believe there are more than a dozen left. Many dropped out, some have died, and at least one of our members gave his life in France.

Being a small year we naturally did not make a very loud noise, and went through the course watching our step. There was, however, one outstanding event in the first year. Half a dozen of our men were stale freshmen, all big husky members of the football team. Their presence, I imagine, had a great deal to do with the fact that the sophomores never attempted any duckings as far as we were concerned. As they failed to do their duty in this case the said stale freshmen undertook to carry out their responsibility. Their plot, however, was discovered and while they were lying in wait in the old cloakroom in the basement after 5 o'clock in order to waylay the rest of us as we straggled in, they were suddenly surprised by the whole year descending upon them in mass. The result was a fierce engagement in which nearly all of the conspirators got the ducking instead of their intended victims.

We were told afterwards that during the height of the combat "Good Old Johnnie" walked the floor of his office wringing his hands and urging everybody to stop the fight in order that he would not have to go down and make trouble for some of us.

During our term the School won its usual number of championship matches and I believe I am correct in saying that the glorious Toike Oike first rent the air. Surely this is enough honor for any year.

Yours truly,

E. H. DARLING.

F. W. Thorold—'00

Replying to your letter of the 4th inst., I take pleasure in recalling a few of the incidents occurring during the years 1898 to 1901 at the old "School."

One cannot think of the old days at the School without thinking of the man responsible for its very existence. Dean Galbraith, known by all as

"Johnny," was the friend of every man there, and when I look back at the various "trials" held in his office in an endeavor to find out which year committed certain outrages (?) I cannot help but remember the little twinkle which used to be in his eye as the evidence was extracted. I think Johnny took about as much pleasure out of those "trials" as we did.

C. H. C. used to be looked on as a pretty fair photographer in those days and Johnny used to send C. H. C. out with the camera to get a photograph of the ringleaders in many of the scraps. Of course, I don't suggest that C. H. C. intentionally spoiled the plates, but such photos were usually out of focus or spoiled in some other way.

Once we stole the cannon from in front of the Military Institute and took it up to the School. Meds soon found out about this and after many battles they captured it. That old cannon frequently passed from Meds to School and back again, and the last I remember of it was that it had been dropped down between two of the Med buildings. Oh yes, we sure did shoot it off and broke lots of windows too.

There is one incident I can never forget. Prof. Duff, also called "Johnny," was lecturing to us in some third-year subject. There was a scrap going on outside between School and Meds. About half way through the lecture Johnny Duff walked over to the window and looked out. We could see him smile. Then, without turning from the window, he drawled out in the lowest tones, "Gentlemen, I think the School is getting the worst of the scrap." Exit 3rd year en masse!

There were an awful number of liars at the School in those days. When Doc. Ellis would endeavor to show us some complicated calculation in chemistry and would say "seven and three are sixteen and this added to eleven is nine" and would then turn to the class and say, "Is that right?" every man there would say "Yes, Sir."

Of course, we had tapping and painting in those days. We practised on our own men and then showed Meds how it was done. We seldom had a scrap with Arts, although they outnumbered School many times.

Speaking of painting, I remember when the stone steps leading to the main entrance of the Red School were painted. The top step was yelllow, the next blue and the next white and so on for all the steps. I forget what the fine was, but there were two men removing paint from those steps for many days.

Taking a hurdy-gurdy through the halls of the School and then into the lecture room was tame in comparison with the time that we took a full-fledged Highlander playing the pipes into one of the galleries at the Parliament Buildings while the House was in session. Why this was done I cannot remember, but I suppose there was a reason (?) There was always a reason for everything we did in those days.

At the time of the South African War, we always had a parade down town when good news arrived. I remember when Kruger was captured, we got a Grand Trunk lorry and mounted a large cage on this. A rather quiet fellow in the first year was "selected" to act as Kruger and he was put in the cage and the cage tied down. He wore a beard and really looked like the pictures of Kruger. The placard on the cage stated that this was really Kruger. All went well until we reached Queen and York Streets and then a mob of kids plentifully supplied with choice rotten eggs serenaded Mr. Kruger. The cage was open on four sides and poor Kruger could not get out.

Hallowe'en night was the big night. Theatre first and then quietly disperse to meet again somewhere above College Street. Of course the police would be on hand in swarms and just as soon as we attempted anything they would charge us. Then we would disperse and meet again at one of the Ladies' Colleges. Once in a while a man would be captured by the police but usually the police were contented if they could wallop a few of the boys on the head with their batons.

We were serious in those days too. I remember we had every newspaper in Ontario publish an article stating that a new Mining Building was necessary at the University. We had letters written to every M.P.P. and many of them were seen personally. We had resolutions passed by the Manufacturers' Association and the Board of Trade stating that such a building was required. All the newspaper clippings were pasted on a roll of paper about 12 inches wide and "miles" long. An appointment was made to meet the Cabinet and our best speakers were selected. The climax came when the roll was dramatically unrolled before the members of the Cabinet and the opinion of the Press was presented in compact form. The new building now stands at the head of McCaul Street.

There were no year yells in those days. Last year the years '98, '99, '00, '01 and '02 organized and called themselves the "Century Group." Watch us at the next Annual Dinner and you will admit that while we are all getting older (not old) we still have lots of the old School pep left.

Five o'clock, Gentlemen.

Yours sincerely,

F. W. Thorold.

And now:

"Five o'clock, gentlemen!"

The lecture is over. The picture of the "Old School" has been drawn to a close. From the dim past, where we have been wandering through the childhood days of our "little Red School house," through exciting police encounters and Literary Society elections, through time-honoured Med. scraps and theatre nights, we reluctantly drift back to 1923. But in our return we have brought with us a new interest and affection. We'll make it a point of having another look at those engraved letters over the northern entrance. Let's stroll around to the old Y.M.C.A. building and make a closer scrutiny of its weather-worn structure. Those old pictures of austere-looking gentlemen, past which we've hurried for that nine o'clock lecture, mean a little more to us now that we've had a look into the bygones.

So we have seen the birth of this School Spirit; we have followed its infancy through the pioneer days when it grew in leaps and bounds due to the necessity of its existence, and now it has reached, in our time, its height of youth. Let us hope that it remains in this youthful stage, may it never grow old, but be a constant source of memory re-awakening for our graduated predecessors who knew it in its childhood, and a constant source of incentive for we who are about to depart from its portals.

We would like to take this opportunity of expressing our sincere feeling of gratitude to these men who so generously contributed articles for this "Old School Reunion." It has brought us closer to them and as we followed them through the memorable past, a closer "tie that binds" has come into existence. The success of this department of the Year Book has rested entirely in the hands of these graduates and the way in which they have responded has shown us that their love and loyalty to our Alma Mater is undying.

This "Old School Reunion" has been a new departure for "Transactions," having its first appearance in last year's issue. The idea was an excellent one and has brought a new interest in this publication, not only for students, who have acquired a new slant on "School's" life, but for those graduates who were present in the foregoing events, this book will awaken old experiences and acquaintances. So may we take this opportunity of congratulating the originators of the idea and of expressing the hope that it will remain as a permanent department of "Transactions."

A
Message of 1923

This is a year of Service. This is a message for the readers of Engineering Society Transactions in this year of Service. Service is needed now just as much as it was ten years or five years ago during the war.

The members of the Engineering Society who have produced this volume, and the undergraduate and graduate members who read it, are living and working in the midst of a period when Service is at a premium. Are you going to take advantage of it?

Yours is the advantage. You are prepared, you are, as young engineers, naturally the kind of persons for Service. It is to you that the State and the Country generally, will look for the nature and extent of Service that is needed for these next few decades in the development of this great Dominion of Canada.

You will spread over the Dominion, over the Empire and over the World. The preparation you have had in this University and the experience you have gained by playing your part in the work of the Engineering Society and in the publication of these Transactions will stand you in good stead wherever you may be and with whomever you may be in contact.

Play the game of Service; it is worth while. It is worth while to the Country, to the profession, to your comrades and to yourselves. May I again ask you to remember the old saying that he who would be great among you must first serve.

My best wishes go to you whether you are graduating or remaining for other years, whether you stay near home or spread to the farthest parts of the Continent. I will expect you all to be serving and subsequently leading wherever you are.

(Sgd.) C. H. MITCHELL,

Dean.

Transactions and Year Book

of the

University of Toronto Engineering Society

With which is incorporated "Applied Science"

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Editorial

With this issue the "Transactions of the Engineering Society" completes the thirty-sixth cycle of its existence and the third since its rejuvenation. The history of the publication is practically a history of the School of Science. It is the Society's official record of accomplishment and is, as such, submitted to alumni and undergraduates.

In collecting material for this volume certain papers have been included which were not actually delivered before the Society but the aim has been to strike a medium between the ultra-technical paper and the general article, yet to have each justify its place in an engineering publication. The Year Book, the account of what Schoolmen have done in the past Session, is a record of real achievement in which everyone has had a part and upon which all may look with true pride.

Attention is directed to the section dealing with the "Old School" for it is upon this foundation that we of the present day and generation must build, and with which we should all be familiar. Only by looking backward upon the traditions handed down by those who trod the path before, may true School Spirit be builded with which to face the future.

And so "Transactions, 1923" goes out. For its shortcomings the fault is our own, and for any merit it may have credit is due to those members of the Engineering Society who have made it possible.

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The Society—and Its Members

On reviewing the past four years from the standpoint of an undergraduate, one is struck with the versatility of the men of School. In the field of sport and the field of learning the men of this faculty have acquitted themselves with great credit. From pink teas to debating platform, from gridiron to squash court, from a rough house to a formal dance, even from the sublime to the ridiculous, following one another with lightning-like rapidity, School men seem to be able to carry themselves with ease. Whether this be due to a chameleon-like character produced by necessity or to a combination of initiative and adaptability produced by environment and training, it is difficult to ascertain.

But one thing seems to be certain and that is, that in School life with its wide diversities of thought and action, the controlling factor in the make-up of character has been the influence of the Undergraduate body known to us as the Engineering Society. In its welding effect it should give a spirit of loyalty and unity as well as a sense of independence which should go far in years to come to produce true citizenship and all it involves— "Wad some power the giftie gie' us—" but apart from parchment and penwipers, the severing of relationships with School, and that which makes School —the Society—will come hard to all of us. And so it is with some slight courage backed by many happy memories that we of this year's graduating class set forth into life to do, to dare, and to achieve, what, we know not yet.

———

Pat Lyle—An Appreciation

School spirit—education—executive and athletic activities. To take an intelligent interest in one and all and to balance properly the pendulum between labs and lectures on the one side and sport and "joy-jobs" on the other has been the problem of many a good School man before this.

Pat Lyle has run the gamut of University experience during this past year. Besides being President of the most unified and outstanding body of undergraduates in the U. of T. he has managed to take an extremely active interest in the affairs of the S. A. C., the Board of Stewards and the House Committee of Hart House. At no time resting on his laurels but ever ready with advice and assistance, Pat has achieved successes the nature of which are granted to few to obtain.

His regime has been one of innovations. In handling the initiation question, establishing School Night on a sound basis, breaking the ice with the employment situation and above all in centralizing the activities of School in the Engineering Society, he has had complete success. At the same time he has handled School's affairs impartially and with a loyalty that is hard to resist and has been responsible to a large degree with the extraordinary efficiency with which matters pertaining to School and Schoolmen have been carried out during the session 1922-1923.

Irish, with the traditional eloquence, earnest and sincere in all things, those of us who have worked for and with Pat have realized what a pleasure it has been to share in his whole-hearted and unselfish endeavours in the interests of his fellow undergraduates.

And so at this time of graduation all School joins with us in saying —Au revoir, Pat, may success and happiness be yours wherever you may go and whatever you may do.

SOME'AT ABOUT THE ALUMNI

The Engineering Alumni Association came into being as the result of the 1919 Reunion that gathered in many of the men who had been for several years active in the various local associations that existed in the larger centres.

Why an Association? It is generally appreciated that there existed among School men a "camaraderie" and good fellowship that is developed to a degree more marked than is general in large transient groups of men. Undoubtedly and very evidently this spirit of bonne entente is the result of a common regard for some thing that, for lack of other descriptive phrase, we call the Old Red School. This does not mean the red brick building and frankly does not mean the staff, nor the so often maligned courses of instruction nor only the sports and episodes that go to make up the happy memories of college days, but it is the "tout ensemble" of these things that may be known as Alma Mater. And Alma Mater commands a regard from School men for all the years after they pass out from her portals. The big family likes, as families do, to hang together and keep in touch, and an association of Alumni was deemed advisable to foster this desire to get together and stick together and to help, where possible, our Faculty, our University and our fellows in the profession. The Association was formed, it has flourished, and with the natural growth of two or three hundred a year that each new graduating class is bound to give, it should grow into a strong active organization.

Opinion is divided in regard to the possible work of the Association, some of its members holding that it cannot be more than a social affair designed to hold together School men and to foster School spirit. Others believe that it can be an active factor in engineering education at Toronto; that in time it may lend valuable counsel and aid to the Faculty and University and in future years may lend some financial assistance to special projects, and many members of this mind feel that the Association cannot continue to live unless it can accomplish some useful purpose.

The work the Association has interested itself in to date includes both phases. It has organized and pulled off Annual Reunion and it has interested itself in and offered counsel and assistance in government investigation of University affairs, in the projection of new and needed courses, in the employment of undergraduates and in many incidental affairs of graduate and undergraduate interest.

The future of the Engineering Alumni Association is bright and it welcomes the advent of the Graduating Class of 1923—hopes that this class will add another strong and interesting group to the Association.

C. E. MACDONALD,'18.

THE ENGINEERING SOCIETY ANNUAL DINNER

Transcending all previous affairs the 33rd Annual Banquet of the Engineering Society in the Great Hall at Hart House has left a memory not soon to be eradicated in the minds of all those who were present on Wednesday evening, Nov. 15, 1922. Food unexcelled, music par excellence, beautiful decorations, witty and interesting speakers, toasts, boxing bouts and burlesques all contributed to make a perfect evening.

Dean Mitchell started the ball rolling by saying grace. When all were seated the famous School quartette beautifully rendered some folk songs. Song sheets containing the latest "hits" were passed around and the hall was filled with the music of nearly a thousand voices. The interval between the first and second course was occupied by the charming rendition of that beautiful lullaby, "Sleep Kentucky Babe," by the quartette.

The first toast was to the King. The President of the Society, in his opening speech said that his remarks should be brief, and illustrating his point likened his remarks to ladies' skirts, they should be short enough to be interesting and long enough to cover the subject.

R. G. Morrison, of the graduating class, proposed the toast to the University, and the President of the Society introducing Dean DeLury, who was to respond to the toast, in view of the absence of President Falconer, reminded him that everything approached a limit. In responding to the toast Dean DeLury proposed that the members drink to the President.

While passing through the Rocky Mountains Dr. Coleman's train stopped for a short time, allowing him and some of his fellow passengers to take in the view, and they were greeted with a welcome "Toike Oike" coming from somewhere among the rocks. In his travels he has come upon graduates of School in every quarter of the globe and further, he went on to say that should he ever go on a geological survey to the Antarctic regions he would expect to hear the same irresistible "Toike Oike."

In proposing the toast to the Faculty, Mr. J. M. Dymond showed that the outstanding feature of S. P. S. was that it had spread. In looking a long way forward to the 50th anniversary he suggested that it should take the form of a huge reunion with exhibitions and theatres showing what S. P. S. had accomplished in the past. These, he said, would act as a great inspiration for the future.

Replying to the toast of the Faculty, Dean Mitchell made some amusing references to the menu card of the 11th anniversary, stating that he was a freshman at the first dinner. He then went on over the old days when Dean Galbraith and Dean Ellis were living. He hoped their memory would ever be green. He gave as an example of our progress here in Canada the difference between the old "sewing-machine" engine he had seen at Port Hope in the early days and our huge modern locomotive. He spoke of the far greater opportunities we had to-day than those of thirty-three years ago. "We are just starting in Applied Science," said the Dean, and he went on mentioning the myriad problems that to-day are still unsolved Among others were: the national railways problem, good roads, the long distance transmission of electric power, heating, development of oil in the West, and the Radio problem, which are still in their infancy.

Mr. MacQueen gave a solo.

The toast to the profession was proposed by A. M. Reid '23. He spoke of the necessity of raising the status of the profession by law, saying that engineering was dynamic, not static, and he deplored the lack of representatives in legislative and arbitration boards.

As Professor T. R. Loudon rose to reply to this toast he was greeted by clapping of hands and many an approving voice. He stated that the registration of engineers was a stepping stone to further legislation and he showed that "the demand for technically trained men is unlimited" and that there was no fear of engineers being a drug on the market.

A toast to the Sister Societies was proposed by H. E. Morris of 2T3, saying that we were all engineers. He wished every prosperity to the societies.

Mr. Dingman of R.M.C. replied, representing R.M.C., McGill and Queen's, in a very smart and attractive fashion vaguely reminiscent of the army.

In an absorbing three-round boxing bout, Maguire vs. Seaborn, drew even.

Mr. Grace, an entertainer, gave some very amusing impersonations. Then followed the hit of the evening when a burlesque bout was fought between "Chatson Hamilton Wright" and Jerusalem Rebekka Cockburn; at the end of three rounds it was a draw. But on overtime Chatson defeated Rebekka by poking him one in the jaw, laying him out for a count. The President of the Society then declared the banquet over and the members dispersed carrying with them a greater love for the Old Red School.

C. A. Norris.

S.P.S. DINNER COMMITTEE.

TOP ROW:—F. J. Wallace, C. F. Cockshutt, E. G. Davies, C.B. Macqueen, C. M. Boyer, N. E. McPherson.
BOTTOM ROW:—C A. G. Wade, T. W. Jackson, C. A. Norris (Chairman); F. J. Lyle, V. D'e. Strickland. W. D. Jewett.

THE ENGINEERING SOCIETY ANNUAL AT HOME

"On with the dance," said the School men on Wednesday night, January 17, and on with it they went. The unparalleled success of the Annual At-Home of the Engineering Society makes it stand out as a social event which beggars description. Each man who had been lucky enough to obtain one of the 350 tickets available appeared resplendent in evening dress; he may have forgotten his programs, or his ticket, but one thing he did not forget and that was to be there and to have "her" with him. And Oh what a sight it was! Did some one remark that the School man was backward in social affairs? Let him read these words and forever hide his face.

Promptly at nine o'clock the expectant couples were received by the patronesses, Mrs. C. H. Mitchell, Mrs. C. H. C. Wright, Mrs. P. Gillespie, Mrs. H. E. T. Haultain, Mrs. J. W. Bain and Mrs. T. R. Loudon, while Mr. Todd bade his band of associated worry banishers and jazz syncopaters to commence their feats of musical excellence.

As if by a miracle the sumptuous Crystal Ball Room of the King Edward was filled with a multitude of joyous dancers. Bumps were exchanged with the greatest of good nature, for though the ball room was large so also was the crowd. And the moon waltzes were enjoyed to the nth decimal place. The freshman who had never been at an event of this kind ceased to worry whether his ready-made tie was on straight and entered into the spirit of the dance. And some there were who, perhaps a little wearied, sought quietness far from the eyes of patronesses in the secluded spots specially provided for "sitters-out" and for which the Eddie is famous. And as if to throw more light on the situation the spotlight singled out would-be Vernon Castles—now one and now the other, with its multicolored beams producing over the whole hall a Kaleidoscopic effect intriguing in its splendor.

Then too there were the butterflies, not real ones but ethereal creations which floated along the walls in a never-ending line. How they were induced to be present is a mystery but that they were beautiful is a fact and that they were there is also true.

In the first half of the evening a diversion was provided by Miss Le Barnes and Mr. Mosher, Jr., who offered a special exhibition of dancing in a most pleasing manner. Their interpretation of the latest ball room dance, "The Bandolero," was particularly well executed and was applauded heartily.

After lunch many innovations were introduced and perhaps the most unique of these was the "Doll Dance." For this absolutely new and orig-

S.P.S. DANCE COMMITTEE.

TOP ROW:—H. E. Stewart, L. F. Stokes, H. N. Baker, G. A. Murphy, J. W. Pearson.
BOTTOM ROW:—W. E. Carswell, H. J. Coulter, C. A. Norris (Chairman); F. J. Lyle, A. M. Johnson, C. T. Sharpe.

inal feature some 25 dolls were "broadcasted" amongst the dancers. These were to be passed from one to the other and when the music stopped the couples holding the dolls were to retire from the dance, passing on the dolls to others. By this elimination process finally 25 couples would be left on the floor and they would be the winners of the dolls. The introduction of this dance brought about great excitement and though not following out to the letter the rules of the dance it was obviously a huge success.

A most delightful feature of this part of the dance was the impromptu dance specially given by Mr. R. B. Kerr and his partner. These young people showed real talent in this line and their dancing was highly appreciated.

All too soon came the hour for departure, but promptly on time the last dance was played and the gay dancers regretfully, though with the knowledge that "all things must end," betook themselves towards the check room and thence homewards.

C. A. Norris.

SCHOOL NIGHT AT HART HOUSE

School Men, otherwise known as members of the Engineering Society, made a distinct name for themselves in the past term by virtue of the fact that they staged the first attempted innovation of its kind—"School Night at Hart House." For the benefit of all and sundry who were not fortunate enough to attend this unique function, a little explanation of the same might not be amiss.

First, for the reason. As is pretty generally known, the halls of Hart House are above all else open only to men students. When members of the weaker sex—to use a much hackneyed if doubtful phrase—do obtain admission within the sacred portals, it is to attend some one social function, a dance or perhaps a recital. As a result they see Hart House only as a Dance Hall or a Concert Hall. Besides, of course, on specified Sundays, the proud student may show lady friends through the house. "We can swim here," says he, as they pass the tank—or "We read here," as they pass the library. "It must be *wonderful*," says his fair partner, but since in practically none of the parts of the building are any activities in progress, said fair partner rarely appreciates the real possibilities of Hart House.

"This must not be," said the School Men. "We will devise a plan whereby our lady friends may view Hart House 'as is.' They must see all the departments in action—even from the rifle ranges to the library."

Pat Lyle, assisted by his Engineering Society executive, as well as by many other willing souls, racked his brains for weeks to devise a plan with a result which was startling, successful, and unique.

"The Shriek"

January 29 was the night set for the glorious event and 7.30 was the zero hour. Every School Man received admission free, and besides this a considerable number of graduates and friends of the School Men were the happy recipients of the precious pasteboards without which it was futile to enter the building that night. The total attendance was about 2,000, or 1,000 couples—need it be said that Hart House had the appearance of being very much alive?

As was the intention, all departments of the House were "wide open." As a result of laborious efforts, three performances of a notorious play called "The Shriek" were given in the Theatre by an all star cast. Digby Wyatt as the Shriek deserves special mention, while Teddy Huggins and Johnny Dumbrille, as the worthy surveyor and his assistant who attempted to rescue "Neuralgia," the distressed damsel, from the hands of the Shriek, played their part to a nicety. Needless to say that Ralph Kerr made a realistic "damsel" whose signs of distress were only too evident. Pete Culliton made a very affable announcer, giving some few necessary explanations at the beginning of each scene. The fact that the lions refused to eat the surveyor when so bidden, proved an insurmountable difficulty, however, which, in every case, precipitated the end of the performance. The Shriek was, however, appeased with a lollypop, and at the end of the last performance the lions were slain and given to the surveyor to eat, since their period of usefulness was over.

But to show Hart House in full swing was not enough. A noisy, enticing, and get-together midway was to be seen and heard along several of the corridors on the main floor. Here Prof. Humbug astonished thousands with his marvellous transformation trick — Pooki performed wondrous mind-reading feats, while Barney Google displayed Spark Plug to curious spectators.

Each department of the different years ran a side-show and the frenzied efforts of the contending barkers were rewarded by enthusiastic crowds who packed around the centres of interest, straining every muscle to win the coveted lollypop or box of chiclets.

Besides the Midway several important and more serious entertainments were in progress at different periods throughout the evening. There were swimming and water polo exhibitions in the tank, basketball games, fencing, boxing and wrestling matches in the gyms. and shooting competitions in the rifle ranges.

The Toike Orchestra provided an excellent programme in the Music Room, whilst Professor Benson gave an exhibition of billiards in the Billiard Room. In the Sketch Room, a fine selection of works by C. W. Jeffries formed the chief attraction.

Then, that none should feel the pangs of hunger, "Hot Dawgs" and Coffee were obtainable in the Great Hall at the nominal rate of 5c per item. The mustard for the dawgs was thrown in gratis. This small

outlay—20c—for she was usually too excited to eat more than one, constituted the sole expense to the wary stude—a remarkable fact indeed.

At 10.30 dancing commenced simultaneously in the Great Hall and the Little and Big Gyms. Bill Turner's Orchestra provided the necessary syncopation in the Gyms., while Zet Frat's orchestra obliged in the Great Hall. This delightful part of the program capped the climax of a glorious evening and at one o'clock the School Man and his partner, sought their respective check rooms and thence journeyed home. Some were on time at the nine o'clock lecture the next morning and some weren't—but they all had a good time the night before. It is to be noted with great delight that School Night at Hart House now bids fair to be an unusual event. taking its place among our most popular celebration events.

J. F. PEDDER.

INITIATIONS

A definite step towards the decision on the initiation problem was made on Friday, Feb. 9, 1923, when by an overwhelming majority a general meeting of the Engineering Society decided in favor of the present system of initiations at School with the sole recommendation that a committee be appointed from Sr. School to co-operate with the Sophomores and Freshmen to assure a smooth running ceremony. While several alternative methods of initiation were proposed, they found small favor and despite the fact that they were excellently presented by their advocates, met severe defeat.

Opening the meeting, F. J. Lyle, president of the Society, spoke of the general growth of opinion throughout the University that the time was ripe for a settlement of the vexatious initiation controversies. He stated that, while the S. A. C. would no doubt draw up a set of rules, as the result of the investigations then under foot, a strong feeling existed that School should battle out the problem for themselves.

Many and varied were the opinions expressed by members of the Society. A few favored a return to the old free-for-all scrap, while another was inclined toward a general University initiation, but no one advocated complete abolition. Some interesting viewpoints were given by members of the Junior Years on the purposes of initiation. The general feeling seemed to be that at the same time as putting the Frosh in his place he should be made to appreciate School and thus unite his year. This idea was enlarged upon together with the opinion that Sr. School should hold the controlling hand and give advice from out their past experience.

After a lively two-hour discussion the meeting placed itself on record by practically a unanimous vote in favor of the present system, leaving in the hands of the Engineering Society executive recommendations towards the mode of procedure in the future with regards to the supervision of Sr. School and the time and duration of the actual initiation and the ensuing social celebration.

W.S. Maguire
A.V. Price
W.S. Wingfield
A.S. Crawford
W.J. McClelland
L.M. Price
A.A. Bell
M.E. McQuarrie
C.A. Norris
F.J. Lyle
T.M.S. Kingstott
J.W. Kennedy
UNIVERSITY of TORONTO ENGINEERING SOCIETY EXECUTIVE
C.A.V. Armour
1st Year Pres.
F.S. White
2nd Year Pres.
R.G.K. Morrison
3rd Year Pres.
W.J.W. Reid
4th Year Pres.
W.R. Beaks

ELECTIONS

School once again surpassed itself in its annual elections. From Wednesday, February 28, until the small hours succeeding the evening of Friday, March 2, all enjoyed themselves; even to the president of the Y. M. C. A., whose words were: "There never was such another night as Friday."

Nominations were held ex consuetudine in the first year drafting room in the roof of the Old Red School. 2T3 enlivened the proceedings by having one man for each position, even to that of Dean, causing much consternation amongst the members of the faculty and the other years. Thursday was spent in violent electioneering campaigns. Festivities opened on Friday with a meeting of 2T3 to listen to the libelous and abusive speeches of fourteen of their number who were running for vice-president of the permanent executive. Immediately after this meeting School gathered in the Great Hall of Hart House where luncheon was rendered exceedingly delightful by some of the various seekers after office with their witticisms. The bill of fare for the afternoon provided for voting and theatres. One theatre party considered themselves lucky in seeing two shows for the price of one. Evening found a huge congregation assembled in the drafting room behind Convocation Hall where, thanks partly to the efforts of the promising M.D.'s of the chemical department, a wild and woolly time was had by all. Numerous motlied games, unlisted in the annals of legitimate sport, were indulged in, punctuated by Pat Lyle and his lantern, broadcasting the results. The grand finale took the form of a real rip-roaring parade which successfully serenaded each and every one of the women's residences and incidentally captured the two iron lions from the front of the Forestry Building. These remained in the possession of School for several days, decorating the steps of the Mining Building.

The elections were appreciated by all good undergrads. of S. P. S. Pat Lyle and his executive, George Langford, and his morality squad were 100 per cent. efficient. All details went smoothly, so much so that parliamentary procedure might well copy.

Engineering Society Election Results

President ..... W. A. Osbourne
First Vice-President ..... W. E. Carswell
Second Vice-President ..... G. W. Smart
Treasurer ..... J. F. Millican
Secretary ..... K. Lally
Curator ..... R. Complin

Chairmen of Clubs

Civil Club ..... W. H. Campbell
Mining and Metallurgical Club ..... Ken Gray
Mechanical and Electrical Club ..... H. J. Pugsley
Chemical Club ..... H. Baker
Architectural Club ..... E. M. Coleman
Debating Club ..... G. Rowat

Athletic Association

President ..... R. Laurie
Vice-President ..... C. A. Morrison
Secretary-Treasurer ..... F. J. Milne
Fourth Year Representative ..... B. C. Matson
Third Year Representative ..... S. Perry
Second Year Representative ..... R. K. Innes

Year Executives

Fourth Year...

President.....W. A. BECKER
Vice-President.....G. ROBERTSON
Secretary.....A. R. COLMAN

Third Year....

President.....H. SMITH
Vice-President.....W. J. CAMERON
Secretary.....J. W. PEARSON

Second Year...

President.....D. W. DOW
Vice-President.....C. T. NUGENT
Secretary.....F. W. BRUCE

Y.M.C.A. Executive

President.....JOHN BEATTIE
Vice-President.....H. PAPST
Secretary.....H. B. RUGGLE

2T3 Permanent Executive

President.....A. M. REID
First Vice-President.....H. E. WINGFIELD
Second Vice-President.....H. B. MORRIS
Third Vice-President.....A. A. BELL
Secretary.....C. A. NORRIS

School Representatives on the Hart House Committees

House Committee—J. M. DYMOND, W. A. OSBOURNE, FREDERICK WALLIS.

Hall Committee—H. S. CLARK, C. S. SNEYD, C. R. DAVIS.

Music Committee—F. B. BOSWELL, H. A. GREENWOOD, D. S. LLOYD.

Billiard Committee—J. D. BURBANK, V. A. MCKILLOP, E. K. MUELLER.

Library Committee—L. C. JACKSON, K. R. SOMMERVILLE, J. A. WILLIAMSON.

ENGINEERING SOCIETY WEEKLY DOLLAR DANCES

Just a few explanatory words with regard to the recent addition to the social life of School.

For some time there has been the feeling amongst School men of the lack of an inexpensive dance where they may meet under a common roof and be sure of a real social evening without the superstitious fear of too much formality.

When the Engineering Society finally decided to create the Weekly Dollar Dance they felt that they were taking a move in the right direction. In doing this they felt they would bring about a closer relationship amongst the students themselves and between members of the school and staff, and at the same time fill this great need.

Have you ever passed the remark that it is strange the number of men in your own year that you know to see but cannot call them by name? This is one thing we hope to overcome. Besides this, all the Professors have been extended an invitation and up to now several have accepted, and we hope that in the future we will be honoured by the presence of those who have been unable yet to attend.

I think I am safe in saying that it is the general impression that an undertaking of this sort is considered a money-making machine. However, any who have taken part in the production of a Year or School dance realized the fallacy of this idea, and realize, to say the least, that it requires great care to even keep such an enterprise on anything like a sound financial basis.

What our object is, is to give at cost to the students of this faculty, an evening of maximum entertainment, and as long as this is appreciated to the extent of an even balance in the books at the end of the year, the Society will feel these efforts were not in vain.

I might also add that there existed an understanding that this dance was exclusively a School affair. We would like to say that friends of School men are always welcome, as we feel sure that they will help us to keep this dance at its present high standard.

In future we intend adding novelties each Saturday evening, and by watching the ads around School, you can keep yourself posted.

Every Saturday evening you will find the Engineering Society at home at the Metropolitan Assembly Rooms, 247 College Street, between the hours of 8.30 and 12.00 o'clock. One dollar per couple, including tax. Tickets may be obtained at the Supply Department.

The above remarks appeared in Toike Oike in the issue of November 28th. When this appeared, the Engineering Society Weekly Dollar Dance was still in its infancy, and those in charge of this new venture were still labouring under the uncertainty of success. Now, however, that

a year year has slipped by and we can consider this new idea from a viewpoint of results, there is only one conclusion, and that is "success."

In the first place, the financial statement was practically all that could be desired. Here, it must be remembered, that this venture was not inaugurated with the idea of turning it into a money-making machine. The policy, putting it short, was "Most for the least," and the three and one-third per cent. loss on the total expenditure of fourteen hundred dollars, is very satisfactory.

Secondly, the present popular demand for a repetition next year, shows that the popular Dollar Dance is filling that long felt want.

A very pleasing feature this year was the way the members of the staff accepted their invitations, and were seen on different Saturday evenings entering into the real spirit of the Dollar Dance.

In conclusion, we would like to say that the Engineering Society Weekly Dollar Dance, born to reality A. D. 1922, has been a real success, and we hope that it has become a permanent part of School life, as the results of this year show, if nothing else, that it is a large factor in uniting a "big and live Faculty."

R. M. Laurie, Manager, Weekly Dollar Dance.

THE TOIKE OIKE

For the benefit of those who are not acquainted with the past history of the Toike Oike, it may not be amiss to outline a little of it here.

Its first appearance was at the Elections in 1911, the idea originating with Mr. Stiles, '07. On this occasion it appeared on each of the three days preceding election day and contained policies and platforms, the last issue containing photographs of the presidential candidates as well. For the next several years it continued to appear at election time and was considered a very important part of them. During the war, however, it disappeared and was almost forgotten. Then, in 1920-21, Mr. Downie brought it once more into the light of day, making it the official organ of the Society, to appear monthly or at the discretion of the Society. As such it has continued to flourish.

This year Toike Oike has made six appearances. The first issue was in September and was intended principally for the benefit of the Freshmen. The second issue, in October, came out the day before the "Old Boys' Reunion," and formed an integral part of the Society's official welcome. It contained the official program of the Reunion, definite information about each event in the program as well as "School" news which was thought would be of interest to the "Old Boys." The next two issues, in November and January, were perhaps of more particular interest to the student body. The last two issues appeared during election week and

were devoted to election propaganda. The first five issues consisted of four pages, but the last one was increased to six because of the unprecedented demand for space by the enthusiastic candidates.

The aim of the Toike Oike has been to be of greatest service and interest to the student in every way. The various clubs were able to keep their members enlightened as to their activities, present and future, as were also the several years. Every effort was made to keep the Schoolmen acquainted with the numerous branches of sport of School as well as the exact position School held in them. No less effort was expended to keep the spotlight on all social activities both Faculty and Year. In each of these departments the activities were very great and it was only by co-operating with the executives of them that we were enabled to do this. It may have been noticed that the Toike Oike did not print technical papers and treatises. That work has been reserved for Transactions, in order that Toike Oike might remain as a newspaper.

In conclusion, the Toike Oike would like to thank all those who contributed to it at any time and thus helped to fulfill its purpose of service to the student body.

W. R. Chowen, Editor Toike Oike.

THE MECHANICAL AND ELECTRICAL CLUB

The Mechanical and Electrical Club during the School year 1922-23 underwent a marked rejuvenation. On returning for the fall term it was keenly felt that some reorganization was necessary, and the matter was quickly investigated. Public sentiment was tested and at a general meeting early in October three plans were submitted to the members for discussion. The first was to split the club into two groups, corresponding to the two departments. The second was to remain as before, and the third was to enlarge the executive by having a vice-president from both departments from fourth year and two representatives from the third year—one being secretary-treasurer—as well as the president, and the second and first year reps. After much discussion the last plan was finally agreed upon by the meeting. The results have since shown the wisdom of adopting this plan.

The first outing of the Club was a trip to Queenston to look over the Chippawa plant of the Hydro. The party, consisting mostly of fourth year men and accompanied by Prof. Angus, to whom the success of the trip was due, and Prof. Price, left Toronto early in the morning on the Cayuga and enjoyed a splendid trip across the lake. The students were cordially received by the Hydro men, who piloted them through the magnificent power house, which proved a revelation to most of the visitors.

E. & M. CLUB.

TOP ROW: H. J. Pugsley (III Rep.); H. P. Ruggles (I Rep.); R. E. Taylor (II Rep.).

BOTTOM ROW:—J. E. Goldie (Vice-President); W. A. Becker (Secretary-Treasurer); Prof. R. A. Angus (Honorary President); H. E. Wingfield (President); J. G. Inglis (Vice-President).

After a truly profitable visit, the party left Queenston in the evening and enjoyed a real old sing-song and smoker on the way home. This was greatly enlivened by the School jazz orchestra.

The second event was a lecture by Mr. Milne, of the City Works Department, on "Waterworks." The importance of the subject was appreciated by all and the speaker had a splendid reception. To make the descriptions given in the lecture clearer, the hydraulic option of the fourth year paid visits to the pumping stations in the city and saw conditions as they existed in a modern waterworks system.

Several city plants were visited by the other years and were voted extremely interesting and of great help in showing the practical application of the theories learned in the lectures.

The big social event of the season for the Club materialized when a dinner-smoker was held at the Walker House. This was attended by almost two hundred members and was voted a great success. The assembly was honored by the presence of Dean Mitchell and Profs. Price and Angus. The speakers of the evening were Rev. R. E. Knowles, the well-known author, who gave an elevating address on the value of public speaking, and Mr. Wills MacLachlan, the first president of the Club and now with the Hydro.

The spring term was enlivened by a skating party on Jan. 26th, and on Feb. 3rd a dance was held at the Metropolitan Assembly Hall. The following week a highly successful smoker was held at Hart House. Movies and musical entertainment were provided as well as eats and smokes and everyone had a real good time.

Probably the biggest venture of the year was a trip to Hamilton on Feb. 20th to visit four large industrial plants. A special train was chartered and left Toronto at eight a.m., with over two hundred men who, on arriving at Hamilton, divided into two parties and visited The Steel Co. of Canada, the International Harvester Co., The Canadian Westinghouse and the John Bertram plant of Dundas. The evening was spent at the Arena, where the Varsity senior hockey team were cheered and supported as they battled against the well-known Tigers, and the special left Hamilton at 11.30 p.m. with a tired but happy crowd.

The final technical meeting was held in C22 on Mar. 1st, when the Bell Telephone Co. gave a demonstration. The meeting was attended by over three hundred men and was voted as being one of the best of its kind ever held in School. On Mar. 8th the final meeting of the year was held when the new president was installed in office and the affairs of the year completed.

Besides these functions, much work was accomplished that will have a lasting benefit to the faculty. An employment bureau was fostered and final arrangements were placed in the hands of Sir Robert Falconer.

Other student matters were investigated, such as the difficulties surrounding vacation work. Progress was made along these lines toward closer co-operation between Council and students.

The manner in which the members co-operated with the executive was very gratifying. These men saw a real place in School organizations for the Club and sought to realize their ideas. They felt the Club to be the essential link between the theoretical work and industrial practice and every Club member seemed to be imbued with the spirit generated by that realization. A great deal was accomplished this year, but much more can be successfully carried out in the future, but it will call for the closest co-operation between the executive and the members. With this co-operation there is no doubt that the Club will attain and maintain its rightful position as the best Club in School.

H. E. WINGFIELD, President.

THE INDUSTRIAL CHEMICAL CLUB

Some of our neighbors, to wit, the professors in the Arts faculty, bemoan the fact that the student of to-day is not over-studious. (Of course, nothing is so good as in "the good old days"). It is hoped that this terrible allegation is untrue, but the fact remains that the student in chemical engineering is not interested in technical lectures in the evening. Probably after being exposed to technical and other kinds of knowledge from ten minutes after nine until five o'clock, the poor, would-be engineer craves recreation at night. Recognizing this fact, the executive of the Chemical Club inveigled the members into coming out to fewer smokers this year and with the guarantee that not even the simplest of chemical formulae would be inflicted upon them. As a result, greater numbers turned out at the meetings.

The executive for the year was as follows: Hon. Pres., Prof. J. W. Bain; Hon. Vice-Pres., Dr. M. C. Boswell; Pres., L. M. Price; Vice-Pres., H. N. Baker; Sec.-Treas., D. A. S. Lee; Curator, R. Hayward; Year Reps., IV. H. F. Robertson, III. A. F. Stuart, II. A. Harrop, I. R. K. Innes.

The year was commenced in the customary way with a dinner at the Walker House with seventy-five present. The speaker of the evening was Mr. Beynon, plant superintendent of the Dunlop Tire & Rubber Company. Mr. Beynon gave an interesting talk on rubber.

INDUSTRIAL CHEMICAL CLUB

TOP ROW:—R. E. G. Hayward (Curator); H. F. Robertson (IV Year Rep.); A. F. Stewart (III Year Rep.); R. K. Innes (I Year Rep.); R. C. Harrop (II. Year Rep.).

BOTTOM ROW:—H. N. Baker (Vice-President; Prof. J. W. Bain (Honorary President); L. M. Price (Chairman); Prof. M. C. Boswell (Honorary Vice-President); D. A. S. Lee, (Secretary-Treasurer).

The first smoker was held in C 22 on November twentieth. Moving pictures of Canadian chemical and metallurgical processes were shown, some of which were: "The Story of Paper," "Cane Sugar Manufacture," "Pig Iron and its By-products" and "The Refining of Nickel." During intermissions the musical and story-telling members of the club entertained. A lunch was served at the end of the evening, which was so complete that, it is said, even the freshmen had sufficient.

On the first Saturday morning in December, Dr. Redman spoke to the club. Dr. Redman, the inventor of Redmanol and now general manager of the Bakelite Corporation, talked on the shortcomings of the young graduate and impressed his listeners with his frank remarks.

Owing to a fifty per cent. cut in the membership fee, the club's coffers have not been so well filled as before. On this account, the Chemical Club dance, which has always been one of the events of the social season, but a financial failure, was not held this year. The Chemical Club took over the dollar dance from the Engineering Society shortly after Christmas and all members interested in the terpsichorean art turned out in full force.

The second smoker was held February twenty-second in Hart House. Again motion pictures of industrial processes were shown. At this smoker the music provided was unusually good. Besides the usual numbers from the musical members of the club, N. S. Grant sang, Fred Scott of the M. & E. Club appeared with his banjo and five members of the Stringed Instrument Club entertained very generously. The meeting finished with a lunch in the great hall.

Twice during the School year the fourth year men have been the guests of the Toronto branch of the Society of Chemical Industry at dinner, and for the meeting afterwards. It was through the kindness of Mr. Shoreman, of the British American Oil Company, and Mr. Neighorn, of the Nichols Chemical Company, that the fourth year Chemicals were invited to these dinners. The first was of the chicken variety and proved very delectable. The second dinner was fun at the time, but if the culprit is ever found who put the cathartic in the apple pie, his death will be a slow and a painful one. Dr. Ralph McKee, the head of the department of chemical engineering at Columbia University, spoke after the first dinner. His subject was "Gasoline Twenty Years Hence," and this illustrated lecture on the oil shale industry was very interesting. The second meeting was addressed by Mr. Francis M. Turner, Jr., of the Chemical Catalogue Company, of New York. His subject was "Chemical Plant Equipment." This lecture was the first of a series of six which were well attended.

With the permission of the author, Herb. McManus, and with the assistance of George Langford, of the Miners, the Chemicals are reproducing the "Shriek" for a smoker of the Society of Chemical Industry on March eighth.

The Industrial Chemical Club is finishing the year's activities with a dinner at the Walker House on March sixteenth, at which it is hoped K. S. Maclachlan will speak. As this will be the last meeting of the year, the club will then be turned over to its new chairman, Mr. H. N. Baker.

LLOYD M. PRICE, Chairman.

THE CIVIL CLUB

The year is drawing to a close, because at this writing we are in the midst of the "School" election campaigns. This is a time for the changes in office, and the shifting of responsibilities. This is also a sure sign of Spring and that the day of reckoning is not far off.

The Civil Club have had a very successful year, and it may be well to give here a resume of their activities since last Fall. The Executive have endeavoured to have some form of gathering at least once a month.

The first meeting of the Club took place in Hart House on the evening of November first. The meeting, which was in the form of a smoker, was preceded by a game of indoor baseball between Civils '23 and '24. Professor Treadgold made an excellent umpire and the game resulted in a victory, to the tune of thirteen to seven, in favour of 2T3. It is rumoured that the 2T4 men should have practised the game harder at Gull Lake instead of being lured away from camp by the night life of Minden. After the game the party adjourned to the East Common Room where Professor Young, who was the guest of the evening, gave a very interesting talk. A Hawaiian orchestra was in attendance and rendered some very fine selections. This was followed by the good old "School" and Gull Lake songs, while the "eats" concluded the programme. About eighty members turned out to this event and a good time was had by all.

The next meeting of the Club was held on the afternoon of November twenty-second, when Mr. Norman MacLeod, president of the MacLeod Construction Company, gave an exceedingly interesting lecture on the "Construction of the Sixteen Mile Creek Bridge." The lecture was illustrated by motion pictures showing every phase of the erection. The interesting point in the construction of this bridge was that the spans used were from an old railway bridge in Eastern Canada. After the piers had been erected the spans were slid into position by means of an overhead cableway. The bridge was about one thousand feet in span and one hundred and twenty-five feet in height. A lively discussion followed Mr. MacLeod's lecture and many instructive details were brought to light. To conclude the programme, two films on Highway Construction were shown. This meeting was largely attended and a good number of students from other departments took advantage of this instructive lecture.

CIVIL CLUB

TOP ROW:—E. C. Shurly (Secretary-Treasurer); F. B. Boswell ('Varsity Rep.); A. F. Hunter (I. Rep.); A. R. Chadwick (III Rep.).

BOTTOM ROW:—W. R. Boake (II. Rep.); W. J. McLelland (President); Prof. C. R. Young (Honorary President); W. H. Campbell (Vice-President); H. G. Clappison (IV. Rep.)

On the afternoon of December the seventh the Club took a trip to Leaside to view the new Durant Motor Company's plant then in the course of construction. Professor Young and the resident engineer were kept busy answering the hundred and one questions of the would-be engineers. The buildings are constructed of reinforced concrete, and cover considerable space. One of the interesting features was the unique and ingenious contracting plant for chuting concrete. Practically all of the concrete on this job was placed by means of a tower and chutes from a central point among the buildings.

By way of a social evening the Club took charge of the Dollar Dance on Saturday evening, December the ninth. The tickets were distributed to Civils only, and as they were limited to one hundred the Club soon disposed of them. Everybody enjoyed themselves and voted it a large evening for a dollar.

Last, but not least, came the famous School Night at Hart House. Here again the Civil Club asserted itself and by way of our contribution to the night's entertainment a photographer's booth was rigged up. The true value of the time spent in the photo laboratory was found on this occasion. Hundreds of photographs of the budding engineers and their sweethearts were taken on this night. The Executive hoped to be able to award a prize to the most beautiful couple. However, after many meetings and much heated discussion we concluded that owing to the great number of handsome School men it would be impossible to award an individual prize to any one couple.

In closing, I would like to thank the Executive for their excellent work, the members for their hearty co-operation and support. At this writing the results of the election are not known, but in any event I know that if any one of the candidates receives the customary whole-hearted support another successful year for the Civil Club is assured.

W. J. McLELLAND, Chairman.

THE MINING AND METALLURGICAL CLUB

As the School year draws to a close we pause to chronicle the activities of the M. and M. Club in another chapter of its history.

The opening of the fall term brought together miners and metallurgists who during the previous summer had ranged over most of Canada and part of the States in search of experience for the future and a financial backing for more immediate use.

The first general reunion of the men took place at a smoker in Hart House in October. Here a fund of interesting information was mingled with humor as the embryo engineers told of their experiences—and lack of experience—in the mines and smelters and on geological surveys. Profes-

sor Ellis concluded the addresses by a description of smelter operations in Wales. At this meeting the freshmen were introduced individually to the Club. After proving that they had the moral, mental and vocal qualifications for membership, they were admitted and allowed to sing the Club Chorus.

At the next smoker the Club was addressed by Mr. P. G. Kiely, secretary of the Standard Stock Exchange, on the "Relation of the Stock Exchange to the Mining Industry." This was a very interesting address and called forth much discussion. Mr. Kiely's address, in addition to giving a few sidelights on the financial end of mining, outlined several sane principles of mining finance and investment which, if followed, would tend to minimize the degree of speculation in this class of stock.

Following the holidays, the M. and M. Club in conjunction with the Architectural Club held a successful dance at the Metropolitan Assembly Rooms. The competition in a "Paul Jones" between the two clubs provided an exhibition of unequalled grace. It was thought at first that the Architects, through their familiarity with Grecian art, would have the M. and Emmers at a disadvantage, but so well did the latter acquit themselves in "tripping the light fantastic" that Prof. C. H. Wright, who acted as judge, was unable to decide the winner and called in the goddess of chance, who bestowed the apple on the Architects.

At a meeting of the Club in February, Mr. C. E. MacDonald addressed the members on the "Production of Nickel and Its New Uses in the Industry." This was illustrated by three films on the nickel mines and smelters at Sudbury. The address was very instructive and timely in view of the recent developments in the nickel market.

Throughout the year the members have had access to the meetings of the Toronto branch of the C.S.M.M., a privilege of which many have availed themselves and which we wish to acknowledge. We also desire to thank the officers and members of this organization for their kindness in inviting Club members as guests to their several luncheons, and to express our appreciation of their hospitality.

"——— seeking riches"

MINING AND METALLURGICAL CLUB.

TOP ROW:—

W. Hansen (II. Year Rep.).
J. G. Ironside (Chairman Entertainment.).
J. S. Dickson, (I Year Rep.).

BOTTOM ROW:—

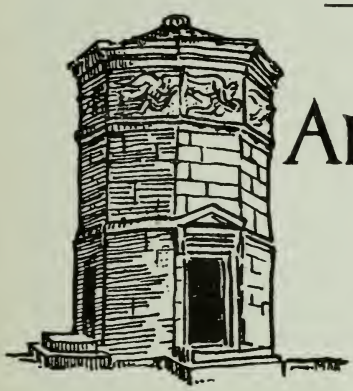
G. C. Mutch (Vice-President);
W. S. Maguire (President);
A. G. Horning (Secretary-Treasurer).

We mention here a departure which, while it has concerned only a part of the Club, has been of great value and is well worth repeating next year. This is the series of talks given each Friday morning to the Fourth Year miners by prominent mining engineers, geologists and mining lawyers, on the development of mining claims and the organization of mining companies. This series of addresses has been arranged by the students. The thanks of the class are due these speakers, who have generously and freely given their counsel and time.

In conclusion, I would like to take this opportunity of thanking the executive for its co-operation and the Club as a whole for its support. In the coming year, K. C. Gray has been chosen chairman, and under his direction we bespeak a successful year.

On behalf of the 2T3 members I wish to bid adieu to the Club. With it we shall ever associate some of the happiest remembrances of our four years at School. We wish it every success in the future.

W. S. MAGUIRE.
President M. and M. Club.



ARCHITECTURE

"Every day in every way the Architects are becoming clubier and clubier."

With the largest membership in its history and a live executive, the Architectural Club has successfully upheld the traditions of former years.

Owing to the nature of the curriculum, the club is more or less self-contained, and, although the spotlight plays with greater brilliancy upon other organizations in School, the Architects are not so far upstage as one might imagine.

The small membership of the club enables the executive to keep a fraternal eye upon the overworked frosh, the underworked sophs, the can't-work juniors and the won't-work seniors. This promotes a "delightful intimacy" (bring your knitting to the next meeting, Melissa) between the uproarious first year, the laborious second year, the stentorious third year and the glorious fourth year.

The good ship "Double Elephant" having weighed anchor (578.3 lbs. S.R.) and having signed on the following as ship's company, steamed away on her voyage early last October:

Rear Admiral—Mr. J. P. Hynes (Pres. O. A. A.)
Front Admiral—Mr. H. H. Madill.
Captain—A. Scott Crawford, '23.
Mate—Miss J. M. Hall, '23.
Steward—J. D. McLean, '23.
Purser—W. E. Carswell, '24.
Chief Engineer—H. A. McIntyre, '23.
2nd Engineer—W. P. Lawson, '24.
Stoker—F. J. Wallis, '25.
Cabin Boy—G. S. Screaton, '26.

Ensemble—Deck Hands, Look Out, Look In, (Erratum, Etide, "Look In." We didn't have one).

Costumes by J. G. Magee.

Note—In the course of the voyage one soul was washed overboard during a storm.

Within the department is an organization which, although almost totally unknown to the average Schoolman, is worthy of special mention—namely the Architectural Club Quartet. This band of songsters has helped to shorten the tedious hours of night work in the studio and has been heard by numerous nocturnal prowlers who frequent the musty corridors of the Little Red School House.

The first meeting of the year took the form of a dinner at the Inglenook Tea Rooms on Oct. 24th, 1922. There was a record attendance and from every point of view the gathering was a success. After dinner short speeches were given by the Hon. Pres. Mr. Hynes, the Pres. A. Scott Crawford, Prof. C. H. C. Wright and Mr. W. A. Golding. An amusing feature of the evening was the initiation of the freshmen. Each one was called upon to speak for three minutes on a trivial subject received earlier in the day from the sophomore committee. A great deal of originality was shown in dealing with these subjects. Following this the freshmen were taught the Psalm of Life and the Toike Oike under the able direction of Don. Ross.

On Tuesday evening, Jan. 23rd, 1923, the club again met at dinner, this time at Mistress Polly's Tea Place. After an excellent dinner, Prof. T. R. Louden addressed the club on the "Relation of the Engineer to the Architect." His remarks covered many interesting and important points not included in the regular lecture course. The club wishes to take this opportunity of thanking Prof. Louden for the interest he has always taken in the boys and especially for honoring us with his presence at this meeting.

Saturday evening, Jan. 27th, was a memorable night. On this date the "T-square artists" combined forces with the "pick and shovel gang" and staged what both the Architects and Miners claim to be the best Saturday Night Dollar Dance of the year. There was a splendid turnout of

U. OF T.
ARCHITECTURAL
CLUB
EXECUTIVE.

TOP ROW:—

G. S. Screaton,
(I Yr. Rep.);
A. W. P. Lawson,
(III Yr. Rep.);
W. E. Carswell
(Treasurer);
F. J. Wallis (II. Yr.
Rep..

BOTTOM ROW:—

H. A. McIntyre
(IV. Yr. Rep.);
A. Scott Crawford
(President);
Miss J. M. Hall
(Vice-President);
H. H. Madill
(Grad. Rep.);
J. D. McLean (Secretary).

both departments and the great success of the Weekly Dollar Dance was again demonstrated. The feature of the evening was a Paul Jones Competition between the two departments represented. Prof. Wright acted as judge, and being unable to declare a winner on the merits of the dances, he asked the two club presidents to come forward. The latter had to guess the number of keys on Prof. Wright's key-ring. Scott Crawford won out for the Architects and was presented with a large box of humbugs.

Of special interest to the club was the visit early in February of Professor Paul P. Cret, of the University of Pennsylvania. Prof. Cret is probably the foremost architectural designer on the continent and he came to Toronto for a few days as the guest of the university to give studio criticisms to the undergraduates in Architecture. While here Prof. Cret was entertained at the Arts and Letters Club and his address on the gigantic town planning scheme, which he has developed and is now carrying out in the City of Philadelphia, was of great interest to all those who were fortunate enough to be at the dinner. The Architectural Club had planned a dinner and theatre party in honor of Prof. Cret, but he was unfortunately forced to return before the date on which this social event was to have taken place. However, much good was derived from Prof. Cret's visit and the only regret was that he was unable to be with us for a longer period.

Early in April the Annual Exhibition of the Architectural Club will be held in the Sketch Room, Hart House. Preparations are already under way for this display of the work of the department. This exhibition is becoming one of the annual institutions of the university, attended not only by the undergraduates of all faculties, but by the members of the profession and many friends of the university. Full announcements will appear later in the Varsity, and everyone interested is cordially invited to attend this exhibition and become better acquainted with the work done in the Department of Architecture.

Later in the term the annual election of officers of the club for the session 1923-24 will be held. On several occasions this event has developed into quite a party. However, we will make no predictions for the current year. Suffice it to say the best traditions of election day in the Architectural Department will be upheld, including the bonfire.

The executive is arranging to hold a "bang up" social function to top off a very successful year. Many suggestions for this affair are under consideration and at present no official statement can be given out regarding the form the celebration will take. However, the affair will maintain the high standard of all School functions and will doubtless be one long remembered and in a class with the Graduation Dance of 2T3.

In conclusion, the president desires to thank the members of the executive for their valued assistance and enthusiastic co-operation in carrying out

the work of the year. Thanks are also due to every member of the club for their support and for the way in which they attended meetings arranged by the executive. May we take this opportunity of wishing the incoming president and his executive every success and the abundant support that we have enjoyed this year.

A. Scott Crawford, President, Architectural Club.

THE SCHOOL DEBATING CLUB

The Club has endeavored during the last year to create more interest in debating generally throughout the school, and has met with real success. It has not only shown to the Schoolmen that they need not feel outclassed by the more purely cultural faculties, but has shown that the debating talent at the School of Science is equal to that of any.

The year's activities were started with one of Professor Greave's very instructive and entertaining talks on "Some Principles of Public Speaking." Professor Greaves showed the Club how they should control and use their vocal organs in speaking. A successful speaker needs much practice to properly develop and use the voice. Five other meetings were held, all taking the form of debates. The first and fourth years were winners in the first round of the Inter-year debates, and in the final round the first year defaulted to the fourth.

The Club met unparalleled success in Interfaculty debating this year. The eloquent theologians of Wycliffe yielded to the sound judgment of Messrs. Rowat and Emerson in the first round. In the second round W. Osborne and J. Dymond proved to the university that the Science Faculty was not inherently less able to debate than University College. In the semi-finals Messrs. Murray and Price, although not able to defeat McMaster, showed that Schoolmen were very worthy opponents of the premier debating college of the university. Mr. John Dymond very ably represented the university in the Inter-collegiate series, which was won by Varsity. His eloquence and forceful debating style drew great commendation from all those who had the privilege of hearing him, both at Toronto and Montreal.

At the last meeting of the Club executive it was unanimously agreed that one of the difficulties in arousing interest in public speaking and debating in S. P. S. was the fact that S. P. S. students will not talk in public purely for the sake of talking. Discussion purely for the sake of discussion outside of laboratories is not entered into with any enthusiasm. In view of this fact, the executive recommends that as well as the scheduled debates and an occasional speaker on some phase of public speaking, the Club should work with the five departmental clubs and hold five joint meetings throughout the year. For these meetings the program of speeches and discussion should be supplied entirely by the students themselves. In

SCHOOL DEBATING CLUB EXECUTIVE.

TOP ROW:—

R. E. Knowles (1st Year Rep.); N. E. McPherson (2nd Year Rep.); A. F. Murphy, (4th Year Rep.).

BOTTOM ROW:—

S. L. Grenzebach (Secretary-Treasurer); Prof. E. A. Allcut (Honorary President); A. V. Price (President); G. H. Ro t (3rd Year Rep.).

this way topics of common interest would be debated and discussed, and the aim of the departmental clubs to increase interest and knowledge in their particular branch of engineering and the aim of the debating club to foster and develop speaking in public would be realized.

The executive also realized that the work which the debating club is endeavoring to do, that is, to teach and develop public speaking in the Faculty of Applied Science, is in reality endeavoring to add another study to the curriculum. This is done because it is felt that those in authority do not supply the instruction for this branch of our development. The executive feel that a large portion of this work could be much better and more easily accomplished by the faculty instead of by a group of undergraduates, and benefit not a few but the whole school. Speakers addressing the students are continually stating that one of the most important attributes for a good engineer is to be able to clearly express himself in a pleasing and convincing manner in writing, in discussions, and in public speaking. These speakers also emphasize the fact that many of the details in the course considered important at the time will be entirely forgotten after graduation, but any training such as in the proper use of the English language under all circumstances will always be of great value. Many students at present in S. P. S. are at a loss to know, if these speakers are correct, why the faculty do not make a more definite attempt to develop in the School of Science a greater appreciation for the proper use of good English, both written and spoken.

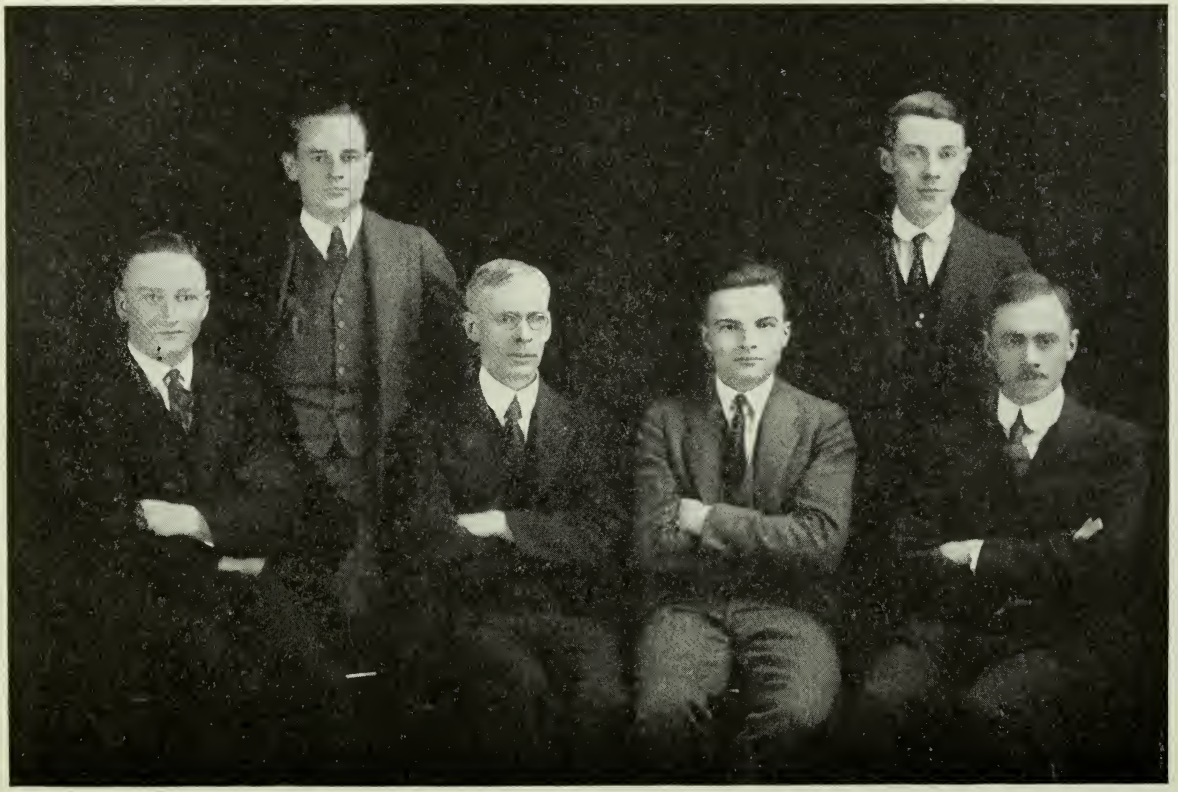
A. V. Price, President Debating Club.

SCHOOL Y.M.C.A.

The first, and one of the very important events of the year, was the "Frosh" reception. Due to the efforts of the committee in charge, the affair was a decided and joyful success. The main purpose of this gathering, to make the freshmen feel at home and to acquaint them with some of the more important men in the senior years, was certainly fulfilled. The entertainment, put on by the freshmen themselves, was enjoyed by everyone and much undeveloped talent was uncovered.

The handbooks were distributed through the "Y" organization as usual, and were better than ever.

The various committees carried on their work as usual and were very successful.



S.P.S.
Y.M.C.A.

TOP ROW:—

G. W. Smart (Campus Service);
T. H. Jenkins (II. Year).

BOTTOM ROW:—

J. Beattie (III. Year);
Prof. R. A. Angus (Honorary President),
J. C. Dumbrille (President);
A M. Reid (I.R.C. Committee).

Tony Reid's child—the International Relationships Committee—had a very interesting and successful year. Many papers were read and discussed and the results, while not commeasurable in actual monetary value, were certainly of immense benefit to those taking part.

The Y. M. C. A. took up the Students' Conference which was held at Xmas this year and we had a representation of ten men there. This conference was the first of its kind and was interesting to everyone; but any description of it would be superfluous as the Varsity has described it in detail.

On the whole we had a successful year and I am sure can look forward to better results next year under the hand of John Beattie, the new President. We who are leaving, realize the good we might have done and the opportunities we missed, but we know that our successors have seen our errors and will profit by them. Anyway the new president is a Miner —"nuff sed."

JOHN DUMBRILLE, President.

THE ENGINEERING INSTITUTE OF CANADA

The history, aims and activities of the E. I. C. are perhaps known sufficiently well by "Schoolmen" to make any detailed reference unnecessary here. An excellent address covering the subject is contained in last year's "Transactions," should anyone desire such information.

The past year has seen growth in the Institute throughout the Dominion. In co-operation with other societies it was instrumental in having The Professional Engineers Act of Ontario passed last year (1922). While not giving as much protection as was hoped for, it is, at least, a start, and schoolmen are asked to support this new organization and join when their qualifications permit.

During the year there has been a healthy interest shown by students in the meetings of the Toronto branch of the E. I. C. In recognition of this interest the chairman, Mr. Wm. Storrie, set aside a regular meeting as "Students' Night" during the fall term. Papers were presented on "Power Factor," "Overhead Cost-Accounting" and "Refractory Materials," by Messrs. F. A. Ellis, D. B. Strudley and H. F. Robertson respectively. A crowded audience of seniors and juniors was at hand, and the greatest possible appreciation was expressed for the character and delivery of the papers. Students also took part in an informal dinner at the beginning of the New Year, the entertainment furnished by our Hawaiian musicians being received with special enthusiasm.

The council of the Institute has recognized the value of student activities by appointing a Special Committee to report on the best methods of linking up the students with the E. I. C. The fact that Prof. T. R. Loudon and R. W. Downie—both past presidents of the Engineering Society—are serving on this committee insures that suggestions and recommendations will be in line with school sentiments. The other members of the committee are the Chairman, Geo. R. McLeod of Montreal, A. M. Reid and F. J. Lyle, the latter in an advisory capacity. While it is not in order to go into any detail regarding this report, as it has yet to be submitted to the Council of the Institute, it may be safely noted that it is strongly recommended that at no time should a Students' Branch of the E. I. C. be formed in S. P. S. The Engineering Society must at all times have the right of way and retain unquestioned control of undergraduate activities. Nevertheless there is need for a thorough presentation to the undergraduate body of the position of the E. I. C. in Canada, and a greater development of contact through the local branch with the graduate engineers in Toronto. The report deals with methods for accomplishing these desirable ends.

The future of E. I. C. activities in School rests entirely with the student body. There are difficulties in the way, and it may be expected that occasionally, as in the past, the situation may demand tact and caution, as well as enthusiasm. The problems of the Institute are, however, the problems of the Canadian Engineer, and in supporting it as students and after graduation by efforts and constructive criticism Schoolmen will be doing their bit towards advancing the interests of the Profession.

A. M. Reid.

The Class of '23 ('24 Meds) is without a doubt the most unique and impressive class that ever did, and if we may speculate on the future, ever will cross the portals of the University. It is a direct result of the cessation of the greatest conflagration that has ever swept this universe. Four years of youth, who, under ordinary circumstances would have come to University in their respective years, found more urgent things to be done. They did their duty to the end and it was then we found four years concentrating themselves in one and forming the classes of '23.

2T3 Science is composed of men with a wide divergence in age from the old soldier who went over in 1914, to the young recruit and the lads just out of high school in 1919. It is composed, you might say, of men who have held ranks at some time or other, varying from general to that of acting private, without pay, for the younger ones were truly acting privates even if circumstances prevented them from getting the pay.

IV. YEAR EXECUTIVE, S.P.S.

TOP ROW:—J. G. Ironsides (M. & M. Rep.); H. F. Robertson Chem. Rep.); F. W. Huggins (Varsity Rep.); C. H. Lucas (Ath. Rep.); H. A. McIntyre (Arch. Rep.); J G Inglis (Elec. Rep.).

BOTTOM ROW:—H. G. Clappison (Civil Rep.); G. E. McClellan (Secretary-Treasurer); R. G. Morrison (President); Dean C. H. Mitchell (Honorary President); H. B. Keenleyside (Vice-President); J. E. Goldie (Mech. Rep.).

ABSENT:—A. S. F. Murphy (S. A. C. Rep.).

There is much that can be said for our members who, on account of age and disability were not privileged to accept the King's shilling. In our united efforts they have certainly done much in putting 2T3 in the position it occupies to-day, and furthermore, they have shown us that three or four years in the army is not an essential for the making of a man, although it may have its advantages. We started in, in the fall of '19, 401 strong, and three years of university life and examinations have collected their due. Of the 401 that started we have barely 225 left. We have had reinforcements from other years and universities though, and to-day the year numbers 256 men (horse, foot and artillery). Our tremendous casualties are due to all the troubles with which a student is afflicted, from too much social or athletic activity, to that of N. S. F., on which most of us can speak with authority.

Looking on the brighter side of things we who are either awfully lucky or very hard working, or both, have been favoured with associations during the last four years the equal of which we can never hope to encounter again. We have got to know each other and our thoughts, our ways of reasoning and outlook on life, have without a doubt been influenced for the better. We all have our faults and limitations but it is reasonable to believe that by constant association with others who are not afflicted with these particular shortcomings, ours should be reduced to a minimum.

Consider any individual whom you have known from the first year; is there not a great change for the better in him? If he was an extremist in any one line I think you will be bound to admit that he has moderated considerably, or at least developed a tolerance for the other fellow's point of view, which is a great asset to him. Consider yourself, aside from any technical knowledge which you might have accumulated during your sojourn here, are you not an entirely different man from when you began? You can't help but be, even if the difference is of that intangible variety which is akin to a woman's smile.

The Year has among its members leaders in every line of thought and in most lines of human endeavour, that would reflect credit on any body of men (with apologies to Miss Hall).

Our contributions to university activities have been of a highly creditable nature and I can safely say that we have had men taking part in each and every one.

In athletics we have always held our own whether inter-year, interfaculty, or intercollegiate. We have had men on every first team representing the university at some time or other. We are honoured in having in our midst a Varsity rugby captain and an individual track champion, to say nothing of the men who have won T's several times over. In all, we have with us 24 T holders and 58 S holders, which brings our quota above that of any other Year in the University, and their efforts have ever been followed with the loyal enthusiasm which they deserve.

We have had one of our numbers President of the Engineering Society, which in itself is no great accomplishment as one of the fourth

year must needs fill the job to the best of his ability. The distinction comes in having one of our own men fill the job in such a capable, energetic and resourceful manner as our genial, curly-haired friend, Pat, has done, and I wish to take this opportunity to express the admiration and respect of the Year for his successes, which have reflected much credit on us as a whole.

The University at present is governed as Sparta was of old, by two kings, one acting as a restraint upon the other. Representing the kings we have two groups of men, the older element with the reserved judgment of experience, and the younger element filled with youthful vigor and enthusiasm, and possibly a few degrees more rashness. The combination results in a most satisfactory state of affairs; just enough giddiness to satisfy the impetuosity of youth and enough reserve to keep the more stable element from growing prematurely gray haired.

One frequently hears representations as to just what will happen when the older element is removed. Will University life divert towards the side of frivolities and foolishness or will it keep on the level course on which it is at present? From my personal observations I am led to believe that the fate of the University can safely be left in the hands of the junior years, as they have to date shown an adaptability to, and a capability for, managing things which at first surprised most of us.

The Executive this year has done its utmost to keep 2T3 activities up to the standard set by former executives. We assumed that our fall dance held at Columbus, Oct. 26, was an unqualified success as our resignations were not called for immediately afterwards. Our graduation dance at the King Edward, Feb. 22, was aimed to be of that quality which is a fitting climax to the activities of a very remarkable year. As no one has offered much criticism we, the Executive, think we are taking no liberties when we say that it achieved its object. With regard to the graduation dance I wish to express the appreciation of the Executive to that resourceful gentleman who so opportunely pinched the lucky supper programme and let Professor J. Roy Cockburn and his partner, Mrs. Mitchell, down so hopelessly in the elimination dance. Without a doubt it was the most popular event of the evening.

Our permanent Executive will soon be taking over office and we know from experience that they are the most fitting men for the positions, and we can safely trust them to look after our interests in the years to come.

In closing I wish to express my appreciation to the Year in general and the Executive in particular, for their hearty co-operation and energy in executing all things undertaken, in such a satisfactory manner.

The thanks of the Year from when it first entered the University are also due J. H. Brown and M. G. Evans, who have given liberally of their time and skill at most Year functions. In fact I cannot recall a Year dance at which one of them was not officiating as general superintendent.

R. G. K. Morrison,
President 2T3.

2T3 "T" Holders

Jack Goldie . . . . . *Boxing*
R. C. Relyea . . . . . *Boxing*
F. S. Seabourne . . . . . *Boxing*
A. A. Bell . . . . . *Rowing, Track, Water Polo*
J. C. Harston . . . . . *Swimming*
A. Conklin . . . . . *Swimming*
A. M. Fitzgerald . . . . . *Swimming*
C. M. Wells . . . . . *Swimming*
G. Lindsay . . . . . *Swimming*
H. L. Kennedy . . . . . *Hockey*
F. Evans . . . . . *Hockey*
G. G. Duncan . . . . . *Rugby*
E. Rolph . . . . . *Rugby*
H. E. Wingfield . . . . . *Soccer*
M. G. Evans . . . . . *Soccer*
N. F. Johnston . . . . . *Soccer*
H. Duffill . . . . . *Basketball*
C. H. Lucas . . . . . *Soccer*

Ex-Members of 2T3 "T" Holders

A. Carew . . . . . *Rugby*
F. Sullivan . . . . . *Rugby and Hockey*
M. D. Earle . . . . . *Rugby*
Glad Thompson . . . . . *Hockey*
M. Wolsey . . . . . *Gymnasium*
J. Smith . . . . . *Rowing*

2T3 GRADUATION DANCE

There are dances and dances, but the graduating dance of a notable year is the one which leaves memories which will remain long after the class has gone out into the world. When, for the last time, men who have worked and played together for four full years gather to celebrate the passing of the final milestone, gaiety is tinged with just a little sadness and each moment seems to pass all too quickly.

Such was the Graduation Dance of 2T3 School held at the King Edward Hotel, Thursday evening, February 22. For the brilliance of setting, for completeness of appointments and for a spirit of whole-hearted enthusiasm and good fellowship, the affair was the best of a series which had established the fame of the class in the realm of entertainment. From nine o'clock until three in the morning each hour was crowded with real enjoyment, and such was the excellence of the arrangements that a new standard was set for smoothness in the carrying out of the program.

The patronesses were Mrs. C. H. Mitchell, Mrs. P. Gillespie, Mrs. J. W. Bain and Mrs. T. R. Loudon, and a real honour was paid to the Year by the manner in which they entered into the spirit of the affair. A feature of the evening was the duet by Messrs. Walker and Grant, while the 2T3 quartet entertained with several pleasing numbers. Most striking among a number of original novelties, was a huge black cat mounted in the balcony, from which came a shower of balloons to descend upon the merry makers. Later in the evening bright coloured tickets and whirligigs wer passed around and provided much amusement. Particularly effective was the skilful handling of the illumination and spotlights which made of a gay scene, a veritable fairyland. Supper was served in the foyer, the galley and the sitting-out room, a feature which substantially aided in the efficiency of the arrangements.

The most delightful event of the evening was the elimination dance, which was carried out by means of supplementary examinations indicated on the individual programs. The winners were Prof. J. Roy Cockburn and Mrs. C. H. Mitchell, which caused much consternation among the judges. It was finally decided to give Prof. Cockburn a test in Descriptive Geometry, in which he proved his proficiency by drawing a straight line through any three given points, and was awarded a diploma as third-class stationary engineer.

For their successful leadership of the troops, the three ex-commanders of the 2T3 School Battalion, Messrs. A. M. Reid, A. A. Bell and John Farley, were presented, on behalf of the Year, with gold pencils by the G. O. C., General Mitchell.

The Year Executive, Messrs. R. G. K. Morrison, G. E. McClellan and H. B. Keenleyside are indeed to be congratulated upon the excellence of a dance second to none held before, in the King Edward, or elsewhere,

So was the social life of 2T3 brought to a close and memories of the last dance will come to many whenever their minds turn to thoughts of the Old School.

Last September found many of the class among the missing and the casualties from the spring offensive, but our numbers were increased to almost their original total by another large re-enforcement from 2T3, and by several students from other colleges.

The desire of the class to dance was evident the first week of the term, so Ed. Carswell organized a group who were famous for their work and ideas on dance committees and began planning the decorations, novelties and arrangements for the annual dance which was held late in October in Columbus Hall. The success of the whole evening justified the great amount of work done in preparation and went further to show that 2T4 can stage a dance in which organization, completeness of detail and originality cannot be surpassed. The Year Dollar Dance at the Metropolitan Assembly Rooms in the second term was enjoyed by all, and such a good time was had without requiring any organizing that more dances of this variety may be expected next year.

After the joy killing effect of examinations at the beginning of the second term it was thought necessary to remove this evil effect by holding a real smoker, so accordingly the class assembled in Hart House and, lead by Jack McLaren, of the "Dumbells," displayed mirth and good fellowship which showed they were all good sports and were willing to be the source and recipient of merriment.

The success of a class or a unit in a large university like ours is not wholly determined by the organization and originality of their dances and the pep of their smokers; but greatly by the number of the class who take an active part in Faculty and University activities and sports. A great number of men of 2T4 have become active in various Faculty and University activities, and in sport the Year is as well represented as any. Among these activities 2T4 can be justly proud of the active interest taken by the members in the Debating Society; when they were freshmen a revival of the Debating Society was held and since that time 2T4 has been the main support of that organization in School. This year two

different teams from this class defeated Wycliffe and University Colleges in debate; this and the choice of Jack Dymond to represent the University is a record that any class might well be proud of. In Intercollegiate and Faculty sport the Year was well represented and credit is due to the many men who gave their time and energy freely to bring honor to their Faculty and University.

Considerable success has attended the efforts of the three Year committees 2T4 has had so far, and may the last be more successful. With Fred Becker as President, assisted by Gordon Robertson and Art Colman, the class will complete a remarkable University career.

W. J. W. Reid, President.

The Year did its best to be an exception to the rule but, nevertheless, we lost some men to 2T6 owing to the April shower of exams. There were others also who, may it be said, preferred to graduate belonging to the class of 2T5, in 1922, rather than throw in their chances with the Freshman year. These losses were, however, ably compensated with promotions from 2T4. After all was said and done, we started the year with a strength of a hundred and sixty-six.

The Year first got together at a cracking good smoker in October, and, as the bumptiousness of the Freshmen could not be tolerated any longer, plans were made to give them a good old School welcome in the near future. Bill Turner was in charge of the proceedings and it was largely due to his untiring efforts that the evening was such a success. Under his leadership everyone was given their bit to do at the coming initiation.

The initiation, when it did come off, did not run along the lines originally planned. Nevertheless, it served its purpose, inasmuch as it bound the First and Second Years together with a tie of friendship that could not in any way have been bettered.

In December, at the Carls-Rite Hotel, the Freshmen, as our hosts, tendered us a royal banquet and the evening will long be remembered by all who attended. The members of the year of 2T6, and especially their executive, are to be congratulated on the novelty and wonderful success of the evening.

The next event of importance to the Year was the Year Dance held at the Metropolitan Assembly Rooms under the paternal guidance and chaperonage of Digby Wyatt. Although it is contended that 2T5 are not "trippers of the light fantastic," nevertheless, the "gang" turned out in goodly numbers and two hundred of the Year and their friends enjoyed a wonderful dance.

Credit is due Eric Taylor, Ross Dickenson and Dave Lloyd for the success of the 2T5 booth at School Night in Hart House. The Year ran a game of chance and everybody present either gambled or gambolled at the booth. A grand prize was presented to the winning couple while all those competing were the recipients of lucious lollypops and evidence of their enjoyment was illustrated by the stickiness of the Hart House corridors for weeks afterwards.

Yet another family gathering took place in the form of a smoker under the able management of Doug. Morton. The event happened at Hart House early in February and, with the assistance of Jack McLaren, of the "Dumbells," everyone sang whether they had a voice or not. Interdepartmental boxing and wrestling were features of the evening.

The Year played a prominent part in all Interfaculty and Intercollegiate sports. Twelve Second Year men helped the Junior School football team bring the Mulock Cup to The Old Red School House once again, while the boxers and wrestlers of the Year captured the championship at the S. P. S. Assault-at-Arms. We were also well represented on both the Soccer and Track teams.

As we progress into our third year (and here's hoping we all come through!) the Year gets broken up into Departments and there is danger of the Departments becoming isolated, but, if the Executive are given good support and everyone pulls together, there should be no fear of this. In closing, the Executive would like to thank the Year for the splendid support it has given. With an excellent Executive elected for the coming year there is no reason why we cannot have a bigger and better year than ever.

PAUL S. WHITE, President.

2T6

Everything must have a foundation upon which to build its future accomplishments. It was to this end that the American colonies sought consolidation under the title of the United States and inscribed themselves as "E Pluribus Unum." Surely, when young men gather together from all parts of Canada, from the United States and even the "Land of the Rising Sun," we may truly say that we are met as colonies in a strange land, our cause, education, our bond of unity, a green tie.

As soon as the executive was elected and duly shown its duties by Mr. Lyle, we settled down to business. Initiation was our nearest problem and formed most of the conversation which one heard in the class rooms. As a class we had our ties pulled out and our hats taken off with but a smile of passiveness, until the time came, when to make it gayer for the Sophomores we assembled outside, gave a Toike Oike and rushed into the building for anything and everything. We certainly got everything it seemed, but it took quite a few to do it, so that afterwards we felt one step nearer to being an engineer.

Prior to the big day, the first and second year executives met in the Dean's office, and then things happened fast. The night arrived and so many things took place that only those who attended it can ever fully appreciate what can be done in one evening. The result was that we were treated to a wonderful evening which was brought to a close in Convocation Hall.

In consideration of this attention from our Sophomore year, we then set about to give our best in the most suitable way. The theatres were dumb to our supplications, so that we finally decided to tender a banquet. To this end the committee worked unselfishly, sparing no expense or time. On Wednesday, December 13th, 1922, both years met in the Blue Room of the Carls-Rite Hotel. President Sir Robert Faulkner and Dean Mitchell were our guests of honor and, of course, a source of pride for the First Year. Bill Turner's Jazz Band supplied the music while Mr. Jules Brazil, assisted by some of the original Dumbell cast, an operatic singer and a few comedians, made an evening's enjoyment all too short. I might say that after hearing Red Newman we had quite an epidemic of "Oh, What a Lovely War." In conclusion to the evening Mr. Church gave us a few words and delighted us with his seriousness.

After our Christmas vacation we began to look forward to a smoker, and on Feb. 2nd, 1923, we met in the East Common Room at Hart House to enjoy a real good evening devoid of all frills. Our class orchestra made its initial bow to us and by all appearances it will be a big asset to our year. Miss Complin made *his* debut as a ballet dancer, while wrestlers grappled until black from dusty mats and the boxers bid fair for the Intercollegiate title. The two cannibals, introduced so aptly by Mr. Knowles, fought a fight to the finish, and everyone having eaten to satisfaction showed themselves well pleased and easily repaid the committee for their time.

We have also sought the athletic field, as will be seen from the following names:

Rugby—

Varsity Senior O. R. F. U.—J. Carrick.
Varsity Seconds—W. Bentley and H. Irwin.
Varsity Thirds—F. Bruce and N. Scott.
Jr. School—F. Buckland, T. Rogers, E. Burbank, F. Roelofson, R. Complin, F. Sampson, D. Dow, E. Cash, A. Hughes and M. Johnson.

Soccer—

Jr. School—C. Armour and L. Barnes.
Interscholastic—C. Armour.

Hockey—

Varsity Jr. O.H.A.—J. Carrick.
Jr. School—A. Sutton, J. Auld, E. Allen and W. Bentley.

Basketball—D. Dow, F. Buckland, C. Armour, F. Patterson, C. Rogers and F. Roelofson.

Track—C. Morrison, H. Ruggle, R. Innes, M. Gooderham and W. Thompson.
Boxing—A. Ormerod, F. Hunter, H. Norman and H. Griffith.
Wrestling—R. Knowles and K. Gordon.
Fencing—F. Barr.

Besides these men, inter-department basketball players are fighting it out for the championship and crests.

We are also on our way to the debating shield and expect to earn it before the year is out. Our first victory was earned by E. Davies and C. Armour against the Third Year.

Owing to the willingness of my classmates to support their executive, things appear to have gotten away to a good start and there is no reason that next year and the ones that follow should not be excellent years of University and Class activities. As for next year, under the guidance of Mr. Dow, our welfare is assured and I wish him every success.

As the academic year closes, and I look back over my friendships in School, it is a source of pride to me to feel how kindly I have been advised by many of our Seniors. Mr. Lyle has done everything possible for me and consequently the year, and Mr. Dymond, who so unselfishly counselled us through the investigation, cannot be forgotten. It is in recognition of such generous service that I offer my humble thanks for my year as a close to our work.

C. V. Armour, President, 2T6.

THE TOIKE OIKESTRA

The work of the orchestra was made possible by the Engineering Society providing a piano and the necessary funds for music. The usual enemy, slim attendance at practices, threatened at times, but the custom of holding practices between five and six o'clock and of giving them good publicity helped in this respect.

The School Dinner was the most important event at which the orchestra appeared during the fall term. The universal feeling of good cheer makes it a pleasure to play at such gatherings and this was no exception to the rule. In addition to this the orchestra played at a number of the meetings of the Engineering Society.

"School Night" was the big event of the spring term as far as the orchestra was concerned. Playing in the music room and providing opening numbers for the performances of "The Shriek" kept the members busy until the dancing started.

In closing I wish to take this opportunity of thanking Mr. P. S. Edwards and Mr. G. D. Maxwell for their loyal efforts on behalf of the orchestra.

S. R. Muirhead.

TOIKE O'KESTRA

TOP ROW:—P. S. Edwards, G. A. Russell, A. H. Burke, W. R. Carruthers, G. H. Voaden, W. L. Rundle, J. J McCullough, J. H. Fox.

BOTTOM ROW:—J. Johnson, B. C. Griffith, S. R. Muirhead, (Leader); C. T. Carson (Chairman); W. S. Yates, D. Lloyd, D. D. Flett.

School Athletics, 1922-23

THE SCHOOL ATHLETIC ASSOCIATION

Every year in every way School is getting better and better. Nothing is more amusing than to hear a group of old, corpulent, bald-headed "has-beens" utter the old cry that things aren't now as they used to be. The average human being is very grateful for this state of affairs. The theory that the scholars are not as brilliant nor the athletes as great as forty years ago must be based on fossilized ideas which have not kept pace with advances. Results and results are proof. Nowadays there are more brilliant men than forty years ago, hence a few don't stand out. In athletics records are continually being broken. Swimming has been revolutionized. Hockey was never on so high a plane—there were not the facilities. Track records are being broken. Skating records are being broken. Rowing has been established in two Canadian universities. Team play in all games is becoming more perfected. The use of brains is constantly increasing in athletics.

School has had an excellent year in sport. Both in championships and sportsmanship, Schoolmen may be proud of their faculty. It is the way a championship is won or lost which reflects on the contestants. In this respect, School stands high.

After a lapse of eight years, Jr. School finally brought home the Mulock Cup. Great credit is due the team and all join in congratulating them. Beattie Ramsay and Don Lee formed a great team as coach and manager. It was very unfortunate that Sr. School was prevented by a misjudgment from entering the finals.

Both the outdoor and indoor track championships were retained, along with the Interscholastic Soccer, the Junior Assault and finally basketball. It is a long time since School won the Sifton Cup. Fortunately it was Jr. School and so the players will all be with us for two more years. Like the rugby, Duffill and Smart turned out a real team. The pleasing feature is that in the other sports, in practically every case, School were runners-up and were eliminated only after a tough fight.

School was well represented on all the Intercollegiate teams. Duffill was captain of the basketball team and Keefler of the swimming team. Varsity, as usual, got its share of the championships.

The executive of the Athletic Association is very grateful to the several managers who all did their jobs faultlessly and to whom much of the credit of any successes is due.

S.P.S. ATHLETIC ASSOCIATION.

TOP ROW:—

F. R. Dickenson (II. Year Rep.);
R. H. Keefler, (III. Year Rep.);
W. A. Bentley (I. Year Rep.).

BOTTOM ROW:—

C. H. Lucas (IV. Year Rep.);
A. A. Bell (President);
K. V. Heyland (Treasurer);
J. G. Cade (Secretary).

It is worth mentioning the record of this year's graduating class. Never before was there such a collection of high-class athletes in one class. A record of 24 T's and 58 S's will stand for many years. The graduation of all these men will leave many gaps to be filled which will call for a strenuous effort on the part of School athletes. However, as long as everyone plays a clean, hard game, the full benefit of athletics will be obtained.

The Athletic Association has a fine new executive. If the students will support this executive whole-heartedly, many more triumphs will be accomplished next year. Let it be everyone's duty to get the freshmen started in athletics while they are freshmen.

A. A. Bell, President.

RUGBY

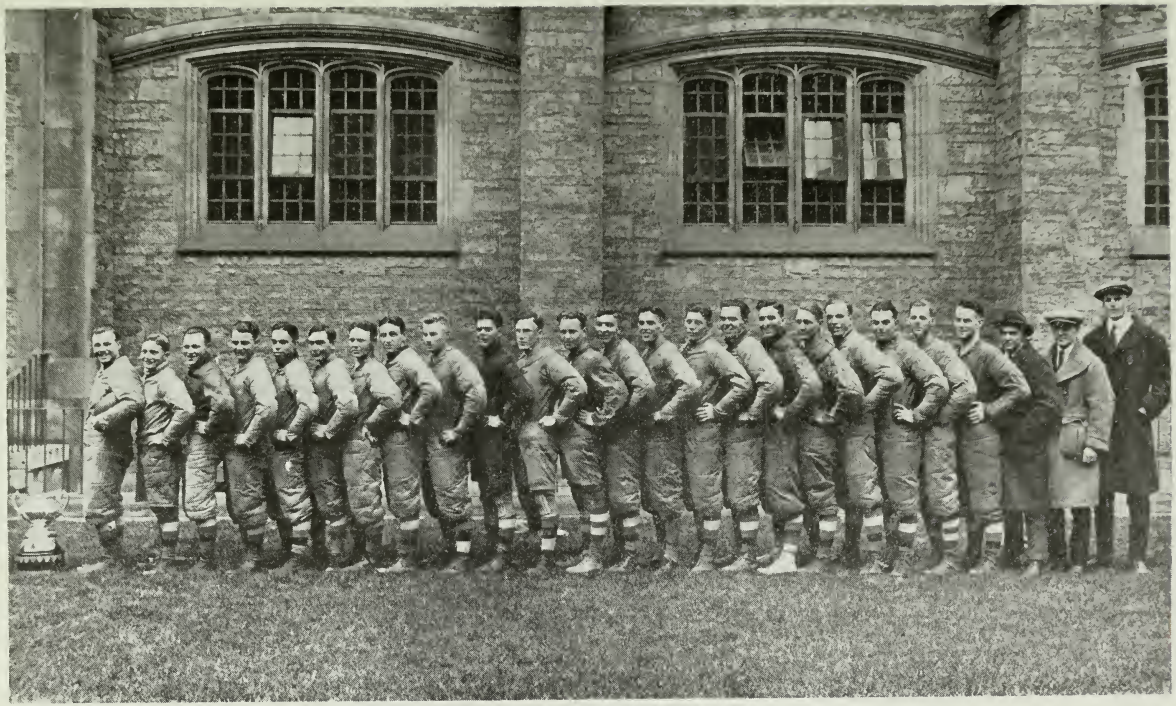
School is back with a vengeance in Interfaculty rubgy. The past season brings back memories of 1915, when Junior and Senior School "fought over the pigskin" in the Mulock Cup finals.

This year Senior School were nosed out by Trinity, due to a little hard luck, an unfortunate decision, not to speak of a fast snappy half line which caught the Seniors napping several times. What Senior School was going to do to the Juniors, if Trinity had not upset the dope, our limited space prevents revealing. However, Junior School have returned the cup where it belongs and we are proud of them. It is the duty of every School man to help to keep it there.

The Junior School team deserves a great deal of credit for their splendid work. Many of their players show great promise and it is to be hoped that some of them will bring further honour to the School by catching a place on the Varsity Senior team.

In 1919 School had eleven men on the Senior Varsity team; in 1920 eight men; in 1921, four men; in 1922, two men. Never in the history of Varsity football has there been a Varsity Senior team without School men represented on the team. Generally, School had the largest majority of men on the team. This spring, the School survivors on the team, Ernie Rolph and Gord. Duncan, graduate. Will the 1923 Varsity Senior rugby team go down in history without a single representative of the old Red School House?

What is to be done? Just this! Let every "School" man who plays rugby, or wants to play, come back next fall in the very best of condition after a summer of outdoor work. Let him turn out to practice with the determination to make that team.



JUNIOR SCHOOL MULOCK CUP CHAMPIONS, 1922-23.

L. A. Booth (Captain); G. B. Sullivan, E. T. W. Bailey, F. R. Dickenson, F. A. Sampson, G. S. Rogers, E. R. Complin, E. A. Cash, G. J. Hughes, F. L. Roelofson, K. F. Parker, H M. S. Pentelow, H. F. Brown, W. G. Lloyd, F. L. Buckland, L. N. Hunter, T. E. Bingham, P. S. White, J. F. Millican, M. H. Johnson, E. F. Burbank, D. W. Dow, W. B. Ramsay (Coach); D. A. S. Lee (Manager); A. A. Bell (President of School Athletic Association).

It will not be on exaggeration to say the result will be that School men of 1923 will uphold the rugby honours which have been set so high in the past by former School men, such as Jack Newton, Hughie Gall, Billy Foulds, Charlie Gage, Joe Breen and many others.

G. G. DUNCAN.

HOCKEY, 1922-23

Now that it is all over, and we can speak of it in the term of memoirs, it has been, to say the least, a year of hard lost games. From Junior School, Jennings Cup team, to the Varsity 1st team, School men have had once again to show their ever present fighting spirit to combat the misfortune that has followed them all year.

Junior School under the leadership of George Cossgrove were forced to take the ice with little practice, owing to the schedule, and had the misfortune of losing their first game. This fact, coupled with the postponed games which had to be played after the regular schedule when sickness hit the team, left Junior School near the low end of the group standing. Here the youngsters showed their mettle in the fact that although they could not win their group, they made the winners fight all the way to earn their victory.

In Group "A" Senior School and Senior Dents were destined from the first to be thorns in each other's sides. Senior School went through the first part of their schedule without a loss. Then the little "world's series" started with the first game with Dent's which ended in a tie. The next game was a 1-0 victory for Dents. The tie game was replayed with a win for School, 3-2. This made the necessity for another game, and a sudden-death was the verdict. Without a doubt this was the greatest game of the year. Full time found the teams on even terms and even at the end of twenty minutes overtime the score was 5-5. In the last ten minutes the first goal was to decide the game and with both teams nearly dropping from exhaustion, they fought on with all they had. With two minutes to go, Dents secured the winning shot and School left the ice defeated, but with the thought that they had fought their best for School. They were both great teams, and to the pleasure of the School team, Dents finished Jennings Cup champions.

School was represented on all the Varsity teams. Dickenson and Garrick were School's rep's on the Junior team, which was under the leadership of Connie Smythe, a School grad. In the O. H. A. they were defeated in the semi-finals after a hard fight. In the Intercollegiate a very unfortunate incident arose. After defeating R. M. C. in the finals 10-1 without the service of substitutes, owing to a misunderstanding in the rules, Varsity 3rd's had to default the Cup.

SENIOR SCHOOL RUGBY TEAM, 1922.

TOP ROW:—Bert Morris (Manager); A. Conklin, J. H. Coulter, C. Woodburn, J. Goldie, W. Longworthy, C. Sharpe, "Tiny" Houston (Coach).

CENTRE ROW:—L. Kennedy, G. Robertson, K. Hamilton, C. S. Sneyd, E. Baird, O. D. Johnston, G. Beecroft, L. Langlois.

BOTTOM ROW:—C. M. Bowyer, R. Laurie, G. F. Dean, B. Jennings, (Captain); G. Kay, L. Stokes, C. Catto.

ABSENT:—R. B. Kerr.

On the Second team, Kennedy and Willford were on the roll. Both these men showed their skill in senior company several times. Lyle Kennedy had the misfortune to suffer an injury to his face, but after a short rest he was back in the game. The intermediates although losing their group in the O. H. A., won the Intercollegiate.

Glad. Thompson, the quiet goallie, was School's only playing member on the 1st team. Beattie Ramsay and Gord. Duncan coached and managed the team to Intercollegiate champions. Owing to sickness, the team got away to a bad start in the O. H. A.

Gord. Duncan, after a hard rugby season and besides managing the Varsity 1st team, was one of the reliable players on Senior School's Jennings Cup team. We wish to thank not only the men that helped School as players, but also Glad. Thompson and Beattie Ramsay for their services as referees in the Interfaculty series.

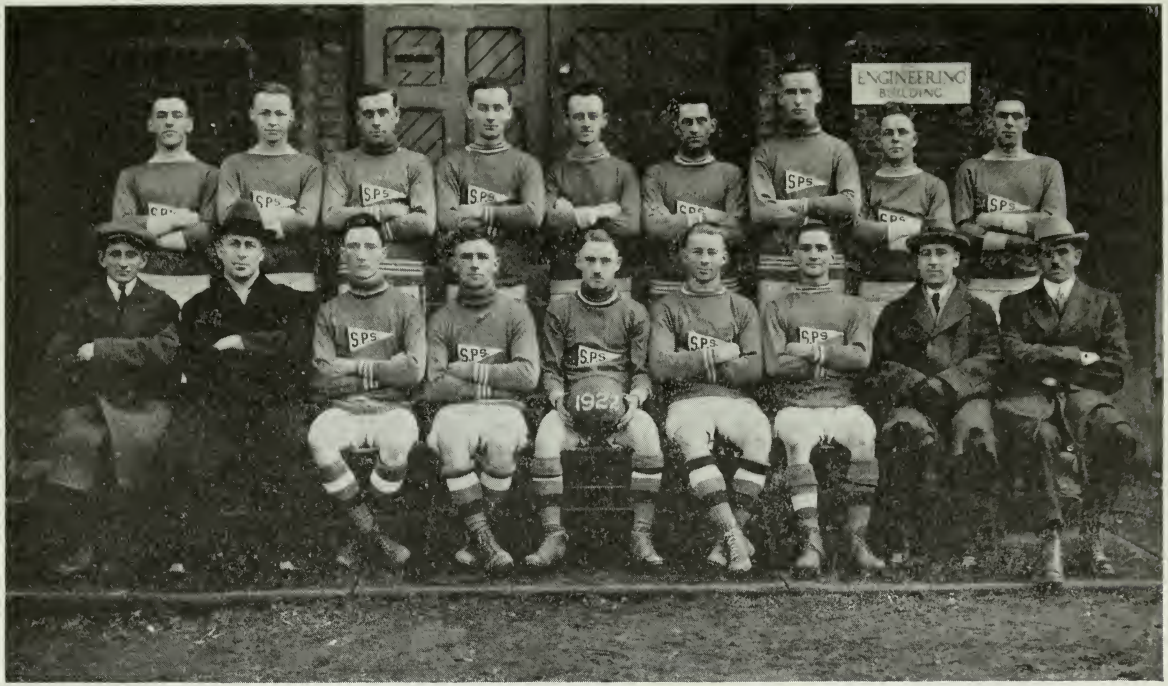
R. M. Laurie.

ASSOCIATION FOOTBALL

Football has had a big year around the University this season, and indications point to a revival of the Intercollegiate Series, which will bring the sport again to its position among the leaders in the athletic world. A most successful tour was undertaken last fall when the Varsity Firsts visited New York, Princeton, Lehigh and Philadelphia. The team won the first game from the well-known Crescent Club of Brooklyn by 7 goals to 0. From this victory they went straight to Princeton and defeated the U. S. Intercollegiate champions by 4 goals to 1. Lehigh University went down by 3 goals to 0 and the tour ended in a drawn game 1-1 with U. of Penn. team, giving three wins and a draw and a total of 15 goals for and only 2 against.

School was well represented on the team in the persons of Evans, Johnson, Smillie and Wingfield. To Evans goes the credit for the remarkably low number of goals scored against the team. They all not only did great credit to their faculty in their efforts in the sporting line, but judging from some snaps floating around School after the trip, they acquitted themselves very favorably in the eyes of the "Belles" on the bathing beach at Atlantic City.

Due to no Intercollegiate Series this year, School entered a team in the Interscholastic Series and landed the championship after some hard-fought games with Meds and Dents, and in the finals with Arts, who had beaten O. A. C. 9 goals to 8 on the round.



S.P.S. INTERSCHOLASTIC SOCCER CHAMPIONS.

TOP ROW:—G. B. Craigie, C. A. V. Armour, G. I. Wilkinson, R. A. Story, M. G. Evans, N. F. Johnston, C. H. Lucas (President); D. L. Melick, T. A. T. Legge.

BOTTOM ROW:—J. H. Browne (Secretary-Treasurer); Prof. J. T. King, (Hon. President); H. E. Wingfield, C. P. Breuls, W. R. Dunbar, (Capt.); J. MacLellan, G. D. Scott, Prof. E. A. Allcut, (Honorary Coach); L. D. Campbell, (Vice-President).

In the Interfaculty Series, School entered two teams, a Junior from the first and second years, and a Senior team from the third and fourth years. There was plenty of material to choose from, especially with the Juniors, who made an excellent showing and promised good for the future. The Seniors were defeated by Senior Dents for the group honors after a very close game, the Dents being later defeated by O. A. C. in the finals.

Soccer will be affected in the same way as all other sports by the passing out of 2T3, but the interest and support of these men will always be given for the sake of their alma mater.

It would not be fitting to close this report without making some mention of the valuable help and experience we have received from the two honorary members of the Club, Prof. Allcut and Prof. King. The former, as Hon.-Coach, has helped us not only in the selection of the teams, etc., but has also been responsible for drawing up a constitution for the Club which will make it much easier for the new executive, with Lorne Campbell as president, to cover the work next year.

The Club is also very grateful to the School Athletic Association in the way they have completely outfitted the two teams, and for their general support this year. It is this kind of co-operation between the Association and the various clubs of the faculty which boosts Interfaculty athletics.

The members of 2T3 wish the new executive and the Club the best of luck in the future, and, by the way, how about a game between 2T3 and School at the reunion next fall? Think it over.

C. H. Lucas.

TRACK

For the fourth successive year, School has captured the Toronto Cricket Club Cup and also the indoor championship. This is a very fine record and it should be the ambition of every school man to uphold and continue the good work.

Unfortunately we are losing several good men this year in "Art" Bell, G. Langford and Meredith and others, but with such men as Innes, Cade, Turner, Morrison, etc., to carry on, we should not be out in the cold.

Last fall we started a new idea in Track work when a very successful Interyear Meet was held, Monday, October 9th. The individual champion was "Art" Bell, who ran away with three firsts in the weight events. 2T3 won the year championship but 2T5 and 2T6 made very good showings and should put up a great fight next year for the championship.

On the following Friday, "Art" again towered above everybody else with the same three firsts and in these events either G. Langford or Bert Morris grabbed a place also. This, along with the good work of Cade, Innes, Meredith, Turner and others, gave us 50 points with Meds and Dents tied for second place with 24 points each.

S.P.S. TRACK CHAMPIONS.

TOP ROW:—

J. G. Cade,
J. E. Buchan,
D. L. Polak,
R. K. Innes,
W. I. Turner,
G. B. Langford,
H. M. Morris,
A. A. Bell,
H. J. Meredith,
C. A. Morrison.

In the Indoor Meet, School again walked away with things, Evans coming within 1 point of being Individual Champion, with Cade, Morrison C. A. and Pollack running close behind.

Several records went by the board at this meet, among which were the Shot Put by "Art" Bell of 41 ft. On the same day, Morrison C. A. lowered the 220 record by 1/5 of a second to 24 3/5 seconds, and Turnbull made the Mile Walk in the remarkable time of 7 min. 29 3/5 sec., which was 22 2/5 seconds below the previous mark. Evans, 2T3, also tied the 50-yard record for the second successive year in the time of 5 4/5 seconds.

In the Intercollegiate Meet, Varsity did not do as well as was expected, but as usual, "Art" was on hand with two firsts, and the showing of our other representatives from School was very encouraging.

In closing, I would like to wish the members of the Track Club the best of success for the coming years and would like to appeal to some of our strong arm men to turn out next fall to replace the trio, Bell, Langford and Morris, who are leaving us this year. This is not only necessary for the School Team, but also applies to the Intercollegiate Team, which next year will have the best chance of copping the silverware that they have had in many years and on our own track too.

J. H. Browne, 2T3.

THE BOXING, WRESTLING AND FENCING CLUB

It has been felt for several years that the Davidson Cup has been too much of a stranger at the "Old Red School." The reason for this is that the sports which this cup represents are not as well supported at S. P. S. as they should be. In a man's faculty, such as School, this state of affairs should not exist.

In order to encourage more interest in this branch of athletics, a School Boxing, Fencing and Wrestling Club was organized last fall. Bob Relyea was chosen as manager to show the boys how neatly it might be done with a right cross. C. L. Brittain, E. B. Hubbard and H. L. Norman were elected to instil the proper spirit in their several years. An Inter-year assault was arranged to secure new material. Men who had won a senior bout or a junior final were barred, so that beginners were under no handicap. A cup was put up which it is intended will be competed for each year.

This School meet was held Dec. 9th, and was successful in bringing out some promising material, besides providing many well-contested bouts. 2T5 won the cup by a good margin with a fine string of boxers and wrestlers.

The winners of these events represented School in the Junior Varsity Assault held a week later. The result was that School had a strong team and succeeded in winning the Junior Interfaculty Championship. This was gratifying considering the poor showing from lack of entries School made in the same contest last year.

In the boxing, Hubbard's performance in the 118 class was particularly good. Toye in the 135 class and Switzer in the 158 class won their finals. In the wrestling School met a doughty opponent in Dents and only took one final, the 175 class, which was won by Jeckell, who defeated his man without difficulty. In the fencing, Grenzeback won the final.

Most of the winners of these two events will be at School for two more years and during that time they have good opportunities of winning further honors for School in Senior events.

In the Assault in December between U. of T. and O. A. C., which the former won, School provided two of the boxers, Bob Relyea and Maguire, who were successful in winning their events.

When Varsity met West Point after Christmas, their boxers were represented in two of the weights by Schoolmen—Bob Relyea and Fred Seaborne—both of whom gave their opponents stiff opposition till the last bell.

In the Senior Interfaculty Assault, School made a strong effort to capture the Davidson Cup. However, this went to the Dents with School and O. A. C. tied for second place.

School's failure to land the prize lay in her lack of wrestling material. What we had was good but there was not enough of it. Before School can make sure of this cup, more wrestlers must be developed. None of the weights should go unchallenged by School. Alex Murray turned in a good performance in the 145 pound wrestling. In the 175 pound class, two Schoolmen contested for this place on the Intercollegiate team, W. H. D. Clark and Jeckell, a bout which Clark won.

In the boxing, Hubbard won the final in the 118 class. "Hub" has two more years at School and it looks as if he could be counted on for this class, not to mention picking off an Intercollegiate championship. He made a good show in trying for it this year.

Bob Relyea won the 125 from another Schoolman, Dave Lloyd. Dave is charging his loss to experience and intends to look after this class next year when Bob has graduated. Bob represented Varsity in the Intercollegiate and drew battlers both nights. He won his first and in the final his opponent's seconds wanted to throw in the sponge after the first round but the McGill boxer insisted on continuing and put up such a game exhibition that the judges gave him the decision.

The 135 class was well represented by School with three men in the semi-finals. Fred Seaborne was forced to withdraw through doctor's orders from the final, which went to another Schoolman—Maguire.

Fred graduates this year and with his departure not only School but Varsity will lose a capable man. Besides being a boxer of no mean prowess, his executive work in connection with the Varsity B. F. and W. Club, of which he has been President during the past year, has added much to its success.

The battle between School's super-heavyweight, George Langford, and Mahon, of St. Mike's, was the event of the Assault. It went four rounds with Mahon getting the decision on points.

A large number of the Varsity Inter-Collegiate team are graduating this year. Here is School's chance to step up and fill the vacancies in the ranks. There are now plenty of opportunities for the beginners to enter the game in the Junior meets and secure experience and confidence for the Senior events. School itself is losing several of its "old-timers" but the men who are left can be counted on to see that School maintains her traditional place—second to none.

W. S. Maguire, Pres. School B. F. & W. Club.

SWIMMING

That swimming is one of the outstanding sports participated in by the men of S. P. S. is ably demonstrated by the water squad in their rigorous training and by the enthusiasm and support which they have received from School. 1922-1923 is the first year since the Fitzgerald Cup was donated for Interfaculty Swimming that it has not found a resting place in the Old Red School House. University College were returned winners over School by a margin of two points. Our relay team, consisting of Harston, Lindsay, Wells and Keefler, set a new record of 1.50 min., breaking the Interfaculty record by 3 2/5 secs. and the Intercollegiate by 2 1/5 secs. Harston won the 50 yards speed, Fitzgerald the 100 yards breast, and Keefler the 100 yards free style, tying Geo. Lindsay's record of 63 4/5 secs., so, although beaten, we were by no means disgraced.

On the Intercollegiate Swimming Team, School were as usual well represented. This year's meet was held in Hart House and was well attended. Varsity gave McGill the worst trimming they have ever received, the final score being 41 1/2 to 24 1/2. Vernot, of McGill, set several new records, the best of which was the time of 2 min. and 19 2/5 secs. for the 200 yards, in which event Wells swam third. Keefler was second to Vernot in the 50 yards free style, while Fitzgerald won the 100 yards breast stroke. The outstanding feature of the evening was a relay race, when the Varsity team, of which Keefler was a member, hung up a new record of 1 min. 46 secs. flat.

And so School's swimming activities are over for another year, which, although not as successful as others, has added yet another notch to the stick of things well done, but with the passing of 2T3 a gentle warning should go out to the rest of S. P. S. to look well to their laurels in the swimming game because School's teams in this sport have for the past four years been drawn from members of the present graduating year.

C. M. WELLS, President U. of T. Swimming Club.

WATER POLO

S. P. S. would have had little difficulty in renewing her triumph of the previous year when the Interfaculty series was won without a defeat, but that five men playing Intercollegiate polo were barred from playing with School. A new team had to be built up during the Rugby season when we missed such men as Booth, Kerr, Kingsmill and Murray. On the turn-out of these men a decided improvement was noticed in School's game and we went through the rest of the schedule without a defeat; but it was too late as Junior U. C. had a strangle hold on the cup.

"Slim" Bell, Conklin, Fitzgerald, Harston and Wells played Intercollegiate Polo again this year and helped considerably in Varsity's 4-1 victory over McGill at Hart House. "Slim" Bell played a wonderful game in goal, while Conklin's work on defense was a treat to behold. McGill's 6-0 victory in Montreal gave them the round and with it the Polo championship for three years in succession.

The following fish took part in the University aquatic activities during the year:—Bell 2T3, Conklin 2T3, Fitzgerald 2T3, Harston 2T3, Wells 2T3, Schinbein 2T3, Murray 2T3, Keefler 2T4, Kerr 2T4, Kingsmill 2T4, Coleman 2T4, Hill 2T5, Booth 2T5, Little 2T5.

C. M. WELLS, President U. of T. Swimming Club.

BASKETBALL

In the past year basketball enjoyed a very successful season at School. School was represented on all the Varsity teams, Captains Duffill and McLean being two of the stars of the Firsts, while Bell and McBride were members of the Senior O. B. A. quintet. In addition to these there was enough talent left to win the Sifton Cup. The Junior School squad followed the example of the Junior School Rugby Team, and accomplished this feat.

The Juniors were a fast, aggressive, well-balanced team who well deserved the championship. They won their group by defeating Knox and Trinity. Knox gave them their hardest battles but Trinity proved very

weak, and in the second game School ran up the record score for this season and perhaps for all time. When the final whistle blew, Trinity was on the short end of a 62-0 score. In the second round, School was grouped with Sr. Vic and Jr. Dents. The Vic team was looked upon as the team to beat, but the Juniors defeated them rather badly in both games and dealt with Dents in a like manner. Sr. Dents were successful in winning their group in the second round and entered the finals against Jr. School. It was thought that the light School defence would have some difficulty in stopping the heavy Dent team but they came through with flying colours. The final score, 25-13 in favour of School, was a good indication of the play.

The team consisted of Little (Captain) forward, Loydd, forward, Dow, forward, Turner, centre, Patterson, defence, Buckland, defence, and Roelofson and Rogers, spares.

The Senior School team was not as successful as the Juniors, as they lost out in their group to Senior Vic. The first game resulted in a 16 to 9 win for Vic, and the second also ended with Vic on the long end of a 16 to 15 score. In both games School had an even share of the play but fell down badly in shooting.

Prospects for next year are very bright. Several of the Senior players are graduating but the majority of the Juniors will be with the Seniors if they do not make one of the Varsity teams. Each incoming first year seems to bring an ever increasing number of high class players, so both the Junior and Senior teams should be just as strong, if not stronger, next season.

W. B. Jennings, Pres. S.P.S. Basketball Club.

JUNIOR SCHOOL BASKETBALL TEAM. SIFTON CUP WINNERS, 1922-1923.

TOP ROW:—

W. H. Duffill (Coach);
F. H. Patterson,
G. S. Rogers,
F. L. Buckland,
F. L. Roelofson,
G. W. Smart (Mgr.).

BOTTOM ROW:—

W. G. Lloyd,
W. I. Turner,
E. M. Little,
D. W. Dow.

ROWING

The 1922 season was really a most successful one. From the standpoint of trophies or championships, the Hanlan Memorial Trophy, emblematic of the Canadian 8-oar championship, was won for the third successive year. It is true many defeats were suffered by the different crews, but the most gratifying feature is the gradual increase in the number of members of the Rowing Club whose enthusiasm and devotion are unbounded and who will, as time goes on, form the backbone of a fine university club upholding the highest ideals of amateur sport.

By long hours of willing and persevering work much was accomplished. In the basement of the school building, under the able direction of Prof. Cockburn, an excellent working boat, the "J. Roy," was built entirely by the oarsmen and a few good friends. It has given and will continue to give first-class service.

The Parkdale Canoe Club most kindly allowed us to house our boats beside their clubhouse and all other accommodation was found in it. The Canoe Club members certainly were ideal hosts and great friendship grew between the two clubs.

The Rowing Club built a long shack for the shells and innumerable floats to launch from. Unfortunately, the shore there was very unprotected and the greatest obstacle to developing first-class crews was the rough water. Frequently rowing was impossible, and sometimes only by waiting till late in the evening was it possible to get out. Thus, for the final month, July, the three crews raced up and down the lake, each man cursing the folly of his predicament, at the same time unable to resist the lure of "another good ten."

The chief engineer and first mate of the coach boat, Kiota, were most faithful in their work and spent much of their summer holiday trying to make a balky engine stop balking.

The crews spent five days at St. Catharines for the Henley, which is becoming finer each year.

The senior crew went to Philadelphia the following week where they were again nosed out of the Championship of America.

This year the crews will row on the bay. A new boat is coming from England and an excellent squad is turning out.

Although winning trophies is gratifying, playing a game for the love of sport is the aim of sport. For this reason, the Varsity oarsmen are all sportsmen.

A. A. Bell.

INDOOR BASEBALL CLUB

A School indoor baseball club was organized in the fall to co-ordinate the efforts of the two teams. The officers elected were: Hon. Pres., Prof. Treadgold; President, G. C. Mutch; Sec.-Treas, J. A. Williamson. Eric Taylor and Ray Sirrs were appointed managers of the Junior and Senior teams respectively.

For the third year in succession the Senior School team lost out to the eventual champions in a group play-off. Much enthusiasm was displayed throughout the season among the players, and all gave the best they had. The pitching of Gord. Mutch, and the catching of Dowe were the features of the play in all games. Ray Sirrs proved a most energetic and capable manager. The following men played in two or more games:

Bell, A. A.; Berner, T.; Brules, A.; Dowe, J. A.; Fitzgerald, A. M.; Fitzgerald, W. W.; Henderson, G. G.; Jennings, W. B.; McQueen, M. V.; Mutch, G. C.; Norman, R. M.; Williamson, J. A.

Junior School, after a hard fight, succumbed to St. Mikes in their group. However some good material was discovered for next year's campaign. Of the men who played in two games, seven were from the first year:

Agnew, R. J.; Bentley, W. A.; Burbank, E. F.; Burns, W. G.; Dickenson, F. R.; Leitch, K.; Little, E. M.; Lloyd, W. G.; Norman, H.; Peoren, J. E.; Teagle, R.; Smith, H.

We feel confident that next year will see School with a toe-hold and half-nelson on that old cup.

J. A. WILLIAMSON, Secretary.

U. OF T. RIFLE ASSOCIATION

At the school night in Hart House this winter, a fourth year man was heard to remark that it was the first time he had known that Hart House boasted a rifle range. So perhaps a few words about the University of Toronto Rifle Association would be in place.

The Association was reorganized in 1919, and is now in its third post-war year. Previous to the war it was quite a flourishing association and School won the DeLury Shield, emblematic of the Interfaculty championship, the three years preceding the war. The total membership is now 120 and of that number School has 25. Dents lead in the matter of membership with U. C. of "Spark Plug" fame, third.

During the fall term, shooting was held daily at the Long Branch ranges and on November 11, the annual Interfaculty and Intercollegiate match took place. Dents won the DeLury shield again this year and Manitoba nosed out first in the Intercollegiate, with Varsity second.

In the winter term, practice was held four times weekly on the indoor range. There were three Intercollegiate matches. The complete scores for the third are not in from the other universities competing, but Varsity leads and the splendid score made at the last shoot make their chances look bright.

In a shoot between three picked teams of the C. O. T. C. and the Rifle Association, all three teams of the latter won.

J. D. Walks.

SQUASH

School's attitude toward squash has developed in much the same manner as the attitude toward spats. Both were at first regarded with suspicion as things outré and primarily designed for U. C. Then came tolerance, with some bolder spirits actually adopting the novelty. Now both are commonplace and going strong.

This year has seen a great increase in the number of Schoolmen playing squash. Perhaps fifty are actively interested in the game, the majority being in the senior years. Twenty per cent. of one of the larger departments in the graduating year play the game. So well has the University as a whole taken to squash that a court reservation for five o'clock is now precious beyond price.

School now holds second place on the permanent challenge board in the person of Steve Greey. Others listed are S. C. Scadding, E. W. Christman and V. D. Strickland.

In spite of the fact that the only hours free to Schoolmen are the most crowded hours at the squash courts, the game bids fair to increase in popularity. Inter-year or inter-departmental tournaments might well be run.

V. N. Bruce.

BILLIARDS

Well, fellows, it's not so good. Apparently the boys from the Red School House are losing their prowess as billiard players, or should we say, are not keeping up to the other fellow. Let's show them next year and bring back the championship that School has held for the past two years.

S.P.S. "T.'s."

TOP ROW:—M. Wolsey (Gym.); G. E. Lindsay (Swimming); C. M. Wells (Swimming); R. H. Keefler (Swimming).

CENTRE ROW:—W. H. Duffill (Basketball); C. H. Lucas (Soccer); W. I. Turner (Track); A. A. Bell (Track); J. C. Harston (Swimming).

BOTTOM ROW:—F. S. Seaborne (Boxing); R. C. Relyea (Boxing); G. W. Smart (Rowing); G. G. Duncan (Rugby); A. M. Fitzgerald (Swimming); H. E. Wingfield (Soccer); N. F. Johnston (Soccer); M. G. Evans (Soccer).

School had a numbers of men entered in the tournaments and some did exceptionally well for comers; H. E. Turner reaching the finals. Switzer, Mueller, Burbank, McKellop and a few others also did well but failed to lift the cup. W. T. A. Bell, last year's champion, fell down in the pinch. So much for this year.

Billiards are becoming more and more popular, so let us see two School men fight it out for the honours next year. Rumor has it that J. M. Dymond is taking special coaching in billiards, and is going to give them all a run. More power, Jack! Let's make it a big year and bring the silverware back.

As in previous years, School will be well represented on the Billiard Committee next year, Mueller, McKellop, Burbank and Bell, all holding down office.

W. T. A. Bell.

CHESS

In this, as in so many other games of a more athletic nature, School has been active during the past year.

The Chess Club is an all-university club, and consists of both graduate and under-graduate members.

The executive for the present and next year is as follows:

1922-23

Honorary President—Dr. Rudolf.
President—J. P. Dandy, IV, U. C.
Secretary-Treasurer—J. D. Burbank, III, S. P. S.
Team Captain—C. H. Meader.

1923-24

Honorary President—Dr. Rudolf.
President—J. D. Burbank, III, S. P. S.
Secretary Treasurer—W. W. H. Coulter, II, S. P. S.
Team Captain—C. H. Meader.

In addition there are representatives for the various faculties. The representative for School was Mr. E. Cowan, 2T3. The 1923-24 executive was elected at the annual meeting, March 21, 1923, and will not take office until the first meeting in the Fall. The School representative for next year has not yet been appointed. However, School is fairly well represented on the executive, considering that Mr. Meader, the team captain, is an old School grad.

As regards the membership of the Chess Club, over half of the undergraduate members are School men. There is something about the game, which is purely one of calculation, that appeals to the mind of a School man who has such constant use for mathematics. This is one field in which, during the past year, our friends in the Medical have offered us

no competition. Besides the regular members of the club, there are a considerable number of School men who frequent the chess room with the idea of playing chess.

The club challenged the Toronto Chess Club to a series of three matches to decide the possession of the Shenstone trophy, emblematic of the chess championship of Toronto, and, I believe, Ontario as well.

Varsity lost the first game, playing eight boards, 2 1-2 games to 5 1-2, won the second, 5 to 3, and lost the third, 3 1-2 to 4 1-2. The last match was very close; one of our players had a won game, but owing to a little careless play lost it and thus losing the match, series and shield.

School is always well represented on the various teams. This year of the four medals presented to those players in their graduating year who had played on any team for two years or more, three went to School men. They were respectively: C. E. Lewis, B. Shaffer and E. Cowan. G. I. Wilkinson, also in his graduating year, although he made a good showing, was not eligible, as he had only played for one season.

E. Cowan was runner-up for the University championship in 1920. B. Shaffer won the Championship in 1921. C. E. Lewis was runner-up in 1922 and has a good chance to win this year.

The School members last year issued a challenge to any faculty or the University as a unit, to form a team of six players to beat them. The challenge was published in Varsity and a match was played. The all-university team used graduate players and yet School using under graduate players entirely, won easily.

J. D. Burbank.

BALANCE SHEET
of
THE UNIVERSITY OF TORONTO, ENGINEERING SOCIETY
As of March 9th, 1923.

ASSETS

CURRENT			$7,274.96
Cash		$ 60.80	
Bank (Current)		1,113.63	
Bank (Savings)		1,002.63	
Victory Bonds		2,000.00	
Accounts Receivable	$412.45		
Less Reserve for Bad Debts	281.65	130.80	
Mdse. Inventory		2,967.10	
		$7,274.96	
FIXED			574.29
Office Equipment	$624.29		
Less Reserve for Depreciation	80.00	$544.29	
Smoking Room Furniture	70.00		
Less Reserve for Depreciation	40.00	30.00	
		$574.29	
			$7,849.25

UNIVERSITY OF TORONTO, ENGINEERING SOCIETY
LIABILITIES
As of March 9th, 1923

CURRENT		$2,653.01
Accounts Payable	$2,653.01	
	$2,653.01	
LIABILITY TO ENGINEERING SOCIETY		5,196.24
Capital Accounts	$5,190.72	
By Unclaimed Dividends from 1922	16.00	
	$5,206.72	
Less Net Loss	10.48	
	$5,196.24	
		$7,849.25

UNIVERSITY OF TORONTO, ENGINEERING SOCIETY
TRADING ACCOUNT
From April 1st, 1922—March 9th, 1923

Sales		$13,889.45
Mdse. Inventory, April 1st, 1922	$ 2,600.00	
Mdse. Purchases	13,265.06	
	15,865.06	
Less Inventory, March 9th, 1928	2,967.10	
Mdse. Sold	12,897.96	
Gross Profit to Profit & Loss Account	991.49	
	$13,889.45	$13,889.45

PROFIT & LOSS ACCOUNT

From April 1st, 1922—March 9th, 1923

Salaries	$ 580.00
Publications	563.09
General Expense	864.54
Alumni	29.40
Dance	56.11
Dinner	67.05
Orchestra	43.00
Grants to Clubs	187.25
Weekly Dance	48.49
Community Night	179.75
	$2,618.68
By Gross Profit from Trading Account	$ 991.49
" Fees	1,494.00
" Interest and Discount	122.71
	2,608.20
Net Loss	10.48
	$2,618.68

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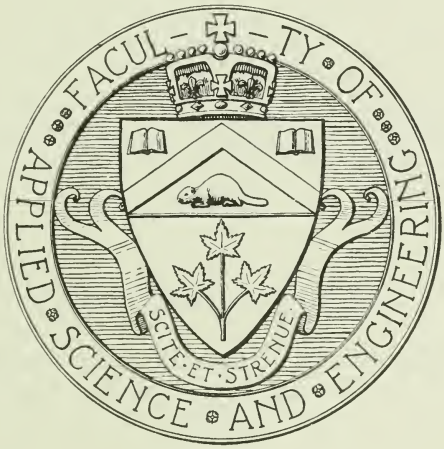

PUBLISHED BY THE SOCIETY

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1923/24

This Volume is Respectfully Dedicated
to the Memory of

Walter J. Francis

C.E., M.E.I.C.

Graduate of

The School of Practical Science
1893

Past President of the
Engineering Alumni Association
and
President of the E.I.C.
at the time of his death
March 6, 1924

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Foreword

ADDRESS OF THE RETIRING PRESIDENT

There is much that might be included in the address of the retiring President by way of a review of the activities of the Engineering Society during his term of office. The object of this book, however, to which my address is intended to act in the nature of a foreword, is to present a synopsis of School's activities during 1923-24, and I shall content myself with a few valedictory remarks, together with a brief resume of one or two of the factors which have had a controlling influence on the general policy of the Engineering Society during the past year.

The "back to normal" feeling which has pervaded all Faculties in the University has been evident also in "School" organizations, and has demanded a re-adjustment of the Society's finances to conform to a decreased income from fees and Supply Dept. profits.

The untiring efforts of my immediate predecessors, Messrs. Lyle, Langford and Downie, have placed the Society on a sound financial footing, while at the same time they revived many of its pre-war activities, and also inaugurated many new ones. The problem for us this year seemed to be, not one of further inauguration of new institutions, but how far in the light of changing conditions was retrenchment necessary.

The "School" Dinner and "At-Home," and the publication of "Transactions" have now become time honoured institutions, and the success of "Faculty Night" is fast placing it in the same category. To maintain them on the high standard of previous years is, we believe, the desire not only of the respective committees in charge, but also of every "School" man. Beyond these our efforts have been directed mainly towards the establishment of an employment bureau, which was begun so successfully last year for the special requirements of the large graduating year of 2T3, and which it is hoped will finally be established on a permanent basis. Such a scheme must develop and prove its worth as it develops, and the money invested in it this year while it is still in a formative stage will, we think, bring rich returns in years to come. There is still much to be done in the building up of an employment organization, but it is speaking for itself, and by the whole-hearted co-operation of "School" men, both graduate and undergraduate, we predict the growth of a scheme which will fulfill our highest expectations and satisfy a long felt want.

The Supply Department, as will be seen from the financial statement, has enjoyed a prosperous year under the capable management of our 2nd Vice-President, and, as usual, has contributed much by its profits to School's activities, But aside from its financial contribution to our activities, the Supply Department has served, and is serving us in many ways, which bring desirable and beneficial results, and these results, though less

tangible are none the less evident as an influence in School life. It is above all a centralising influence, as in it the School man finds his Mecca, and through it the Engineering Society is constantly kept before its members as the hub of activity, in which the efforts of all the individual year and club executives are co-ordinated for the smoother running and unification of the whole. It has in a small but highly useful way functioned as a bank, and its work in this way will be appreciated when it is remembered that the largest proportion of its cash sales each day has been deposited at the bank in the form of cheques, which have been cashed for Schoolmen during the day's business, and in this connection be it said to their credit that the service thus rendered to them has in no way increased our worries.

Engineering Society meetings have, on the whole, been very well attended this year, and deservedly so for the speakers have been outstanding men, with a real message for students. The work of the "School Publicity Service" did much for us in this connection, for it is largely a matter of keeping the meetings before the members and our advertising was greatly facilitated by the help of an efficient and experienced staff of sign-writers.

It would be very difficult for me to try to single out members of the executive and the various committees for special mention, where all are deserving of commendation. One of the chief duties of the President seems to me to have been to effect co-ordination of the work of all committees and clubs, and that task has certainly for me, been reduced to a minimum by desire for co-operation and a spirit of service on the part of all the executives and committees which go to form the greater central organization. Time and effort have been given unsparingly by all, and their reward has been the success of their respective departments of activity and the appreciation and support of their class-mates.

To the Dean, and all members of the staff, I am under a debt of gratitude for their advice, and interest in the well-being of the Society, and to all School men I am indebted for a continuance of that loyality which has always characterized their attitude towards the "Little Red School" and all its institutions and traditions, which is the basis of School spirit.

To Frank Millican, on whom will devolve the duties of President next year, I wish every success in the undertaking. May he have the same kind friends and ardent supporters to whom he may turn for guidance when he needs it.

W. A. Osbourne.

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ENGINEERING IN EUROPE*

By Dean Mitchell

Gentlemen:—You have been good enough to ask me to speak at this inaugural meeting of the Engineering Society for the present session, on subjects of engineering as I observed them in my recent tour in Great Britain and Europe this past summer. In doing this I have been at a loss to decide not so much as to what to include in my remarks as to what might be left out from the many things which came under my observation, as the time at my disposal is so short.

I wish to ask you on a tour at first in a manner somewhat similar to that which I myself followed in leaving Canada in May and going over to the old land, spending some time in the early summer in England and then passing on to the Continent, visiting France, Switzerland and Northern Italy. In this journey I saw many things in engineering work of various kinds which were of great interest to me and which I am sure will be to you.

Come with me in one of the large C.P.R. liners sailing from Montreal and going down the St. Lawrence and out through the Gulf. One cannot fail to be stuck with the progress made in recent years, not only in the construction of large ships but in the many appliances in connection with their navigation.

Our own St. Lawrence route, while at a disadvantage on account of the comparatively short season, has much in its favour when we realize that there is practically 1,000 miles of smooth water from the interior of the Continent down to the Atlantic Ocean until clear of Newfoundland. This considerably shortens the trans-Atlantic trip, and, in fact, the time in the open sea crossing to England by our Canadian route is really only four days with ships even of moderate speed. Our Canadian Government has been rapidly improving the navigation of the St. Lawrence, and as one passes point after point one sees the twinkling light houses and the navigation aids so necessary in a route of this nature. The many inventions

* Address to Society, Oct. 17, 1923.

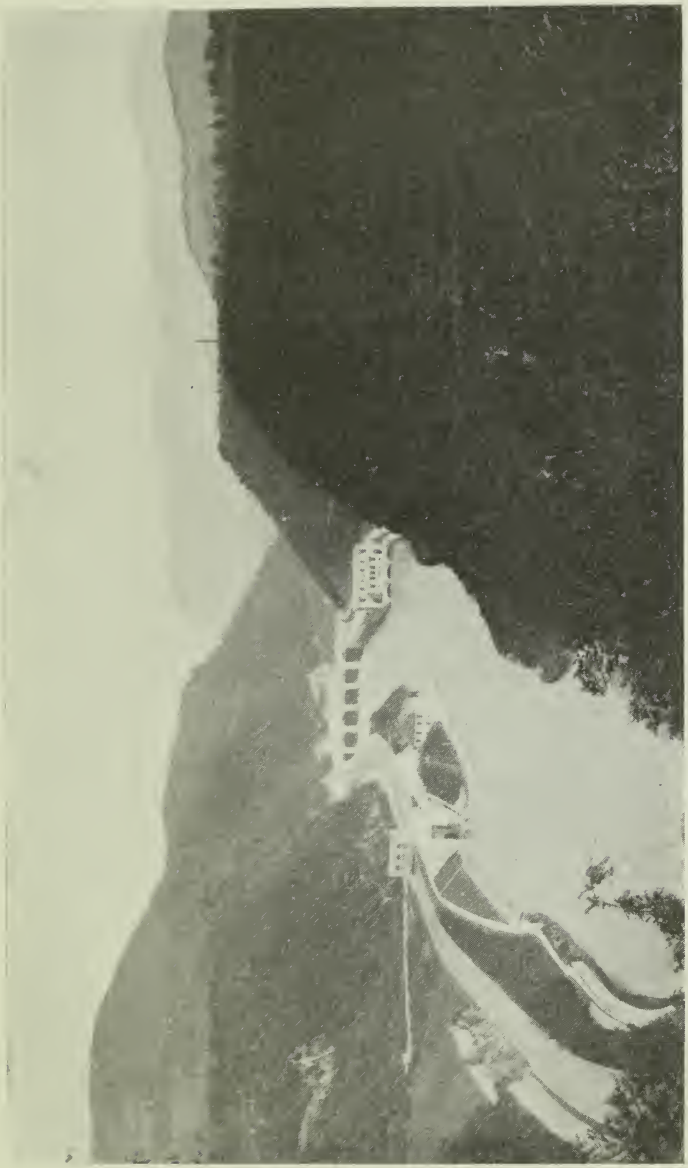
and application of science have had no better recent examples than we met in this voyage in connection with the unfortunate wreck of a large ocean liner which was preceeding us, on the south coast of Newfoundland. It struck a rock in a fog in the afternoon and sank in 50 minutes. Wireless messages were sent in all directions and vessels hastened to their assistance. The passengers, however, were got off the ship in sixteen boats inside of 20 minutes and were landed safely ashore within two hours from the time of the accident. This was a marvel of rapid action and of the use of scientific appliances of various kinds.

Arriving at Southampton one is struck by its huge new harbor which has been such a factor in the development of ocean traffic to and from England. Here one sees the largest trans-Atlantic liners and magnificent and even colossal dock equipment used in connection with them. One sees not only large equipment for loading and unloading, but the various means of rapidly supplying these ships with fuel, both coal and oil. On my return home it was of great interest to see the operation of an oil burning trans-Atlantic liner on which I travelled; a great advantage over the other in many ways.

In England one of the things which first appears in which engineering enters is transportation. I do not wish to take the time to compare their railway trains with ours, although I must say I think their method of passenger travel is preferable to ours in their ordinary coaches, although our sleepers are better. The great feature is their very rapid and efficient methods of handling crowds of people. When you think of it they can empty a crowded passenger train as quickly as it takes eight or perhaps ten people to walk out of the door of the carriage on to the platform. Then too, they are far in advance of us in the speed of their railway trains. We think here in America that we are the last word in speedy transportation, but the British far surpass us. I travelled on one ordinary through express train from Devonshire up to London in June, exactly 200 miles, which made the distance in 220 minutes, including three stops and the entrance into London. And this was not their fastest train; the same Company had a summer train on later which did the distance on an average of 62 miles an hour.

The roads of England have been noted for centuries. Now, with the advent of motor car travel on a large scale these roads are being greatly improved, just as our own. Of course their problems are not the same as our here, and every time I have studied engineering work of this kind in the Old Country it has always been with a sigh that I have said, "Oh yes, we could do the same thing in Canada if we did not have the frost and the cold weather." Curiously enough they have not as many motor cars in England as we have on this side. When you consider the density of the population and the magnificent roads, the ratio of motor cars to population has not advanced nearly as far as it has with us with our poor roads and scarce population.

In connection with transportation it is well known of course that London has very difficult problems to deal with, large crowds and crowded streets both on the surface and underground. The interesting feature about this is the great development and success of the motor bus which



Paderno Power Plants on Adda River, below Lake Como, near Milan, Italy. The Dam and Station in the distance is a new one, 8,000 h.p. The original plant, 15,000 h.p., is above, and the latest, 30,000 h.p., below.

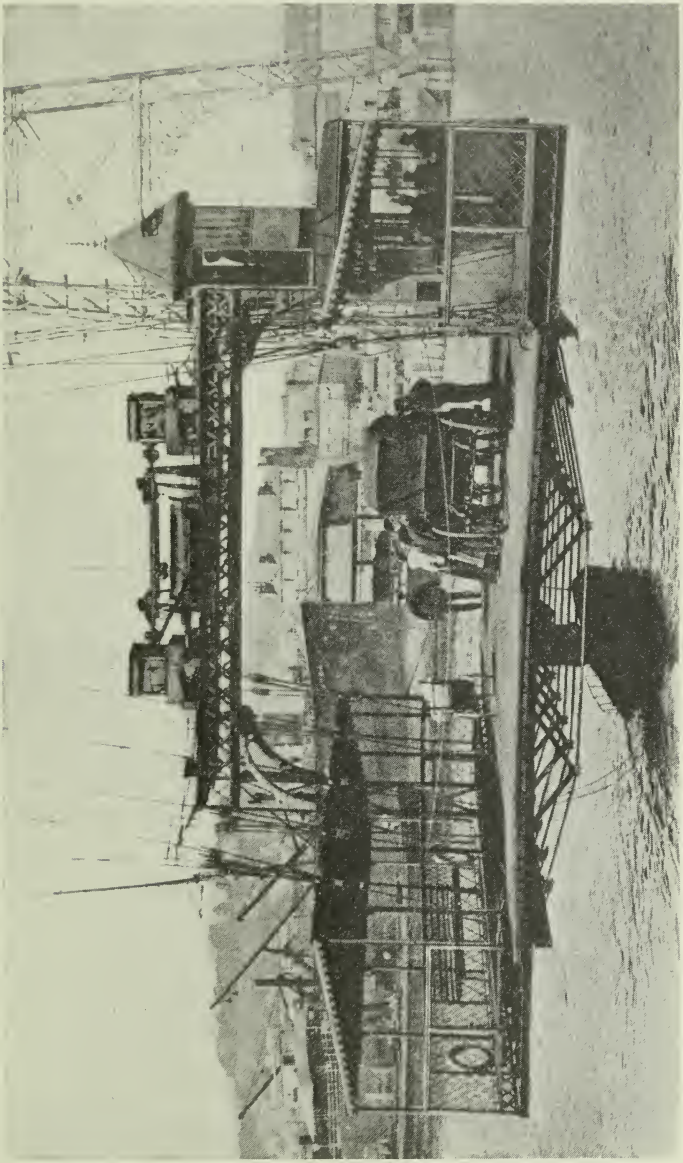
seems to be everywhere. This has been a development only of the last fifteen years, and where twenty years ago there were hardly any motors on the streets of London, there are now hardly any horses. London, however, has some large problems still to solve in its traffic organization, especially in those roads running north and south and crossing the Thames. We have no conception on this side of the water of what a block in the street means compared with some of those I saw this summer on some of the many thoroughfares such as in the Strand.

In 1900 the people of Greater London travelled on the various local systems of rail and bus at the rate of 159 per head per year. In 1920 this had increased to 418; this shows the great increase in the riding habit and facilities in twenty years.

The other new development in transportation is in civil aviation, which has already become a part of London and English life, There are now regular air routes and daily services between London and Manchester, London and Paris and other points on the Continent.

Coming over to France and still considering transportation it was interesting to observe that the French railways had not yet recovered from the war as the British had done. Their road beds were still poor, and if trains attained speed, which they seldom did, it was rough riding. The fastest trip I had was on the Orient Express running from Paris, through the Simplon tunnel down into Italy and across to the near East—I was in a sleeping car marked Constantinople. It was fast, as I say, but too fast for the road bed practically throughout the whole route by which I travelled to Switzzerland. The easiest and best road over which I had a chance to go was on the Orleans Line from Tours down along the Loire River valley, to Nantes in Britanny; it was throughout about the same as our own C.N.R. main lines between here and Montreal. One exxperience in transportation in France, however, must be drawn to your attention, and that is the rapidly extending use of the motor "diligence," which the P.L.M. Ry. in south eastern France had developed to an extraordinary degree, especially in the mountains and the Riviera. They have regular routes in all directions from principal centres several times a day on long runs from 50 to 100 miles in exceedingly comfortable motor cars carrying from fifteen to twenty people over excellent roads, some of them very picturesque.

I saw various interesting bridges on this trip, some of which were new, not only in construction, but intype. The bridges over the Seine in Paris have always been of great interest to me, and comparing them with those over the Thames in London they are much more aesthetic. One feature about the Seine bridges is the flat arch type, either in masonry or concreate, and these become a factor of some importance from an hydraulic point of view when the Seine River goes into flood and rises to such great heights as it frequently does. Several bridges of interesting type have been developed in France to cross harbors and rivers which are full of shipping. One type, for instance, is that of the suspended car travelling across just above the water carried from a light steel bridge structure supported between high towers on either side; types of these are at Marseilles, Nantes and Rouen. Another type which is unique is found



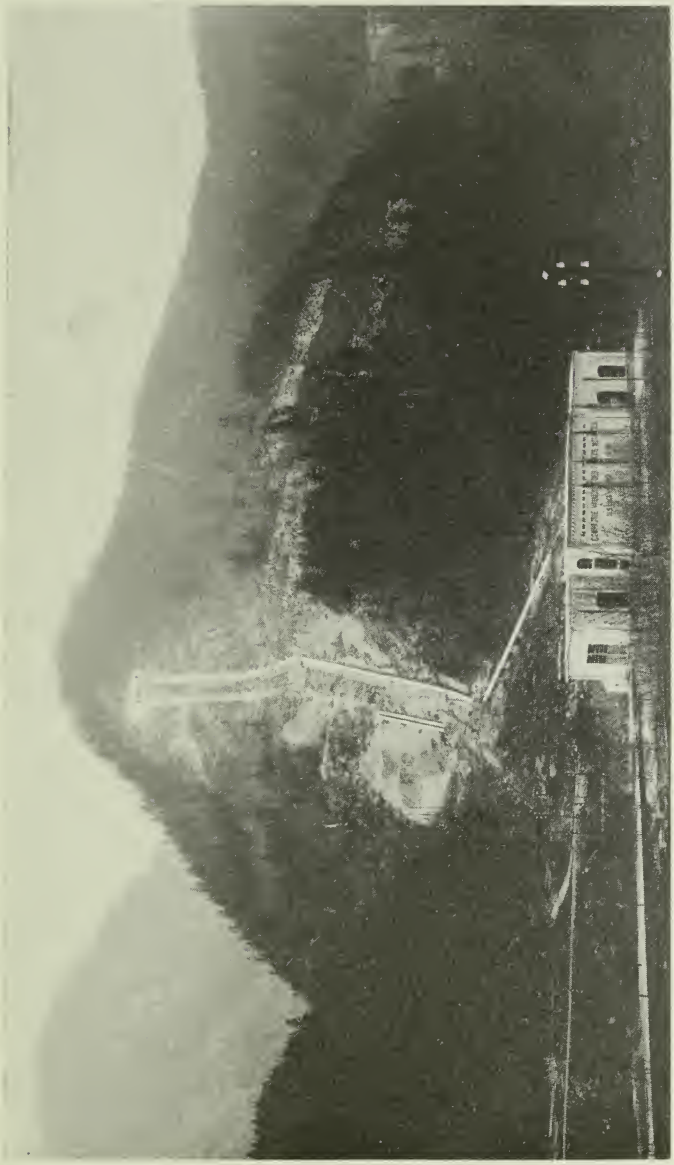
"Transporteur" Bridge over the Seine at Rouen, France.

at St. Malo in Britanny, which really is not a bridge but a railway car which is raised on a steel structure carried at a level above high tide, and running on wheels travelling along rails laid on the bottom of the harbor. This is really a ferry for carrying passengers and vehicles.

In Switzerland there is even greater interest to be found in the engineering in connection with their transportation systems. They have of course the usual steam railways which are really very good and efficient, some of them on quite steep grades. When one realizezs that there is no coal in Switzerland, and what they use has to be brought from France or Germany or even England, one can realize the importance and the great value as a national asset of their water powers. This has naturally brought about a process of gradual electrification of many of their railway lines, and at the present time some of their main steam lines are being electrified on a very large and powerful scale. Portions of these were under electrification before the war, and this process has gone on extensively during and since the war. It is interesting that this can be brought about the more readily by Switzerland because, as they have had no burden of the war to any extent and have profited in a very large measure, they have been able to finance in a large way these public undertakings.

The most interesting features of railway transportation in Switzerland, however, are the steep and difficult mountain railways of various kinds. These comprise the original rack and pinion or cog railway, such as was introduced there twenty to thirty years ago, and operated by steam; the straight electric traction railway which operates up to grades of 8 to 10%; the combination of both the electric traction and rack and pinion on the same lines depending on the steepness and then the latest, which is the aerial or cable way system for high mountains. A sample of the original steam is at Chamonix, very slow, but sure, leading up to the Mer de Glace. The final example of the straight electric traction is in the Lotschburg line, which runs between Brigue and Spiezz, on Lake Thun, the last word in fine and modern transportation, including a tunnel about seven miles long, and a number of spirals in the most picturesque valley in the locality of Kandersteg. This latter railway carries through passenger cars and sleepers as a main line system running between various parts of Europe. Interesting and highly exciting examples of combined traction and cog electric railways were in the Jungfrau Mountain, much of which is in tunnel,, and on the Gorner Railway near Zermatt. The former has its topmost station at an altitude of about 12,000 feet, and the latter at about 10,000 feet above the sea. There are several aerial cable way systems, one of which has been in operation for some years at the Wetterhorn, near Grindelwald, and a new one just now nearing completion in the Chamonix Valley (in France), leading up to a mountain along side of Mt. Blanc.

I suppose that I should speak of some of the mountain roads which, of course, are very unique, not only in Switzerland but in the Italian Alps as well. I have been over various roads, some of them at altitudes up to 7,000 and 8,000 feet above the sea, and it is extraordinary how the locating engineers seize on opportunities to keep the alignment and the grades co-ordinating with what appear to be an almost impossible situa-



High Head (770 ft.) Swiss Power Plant at Vallorbe, near French Frontier.

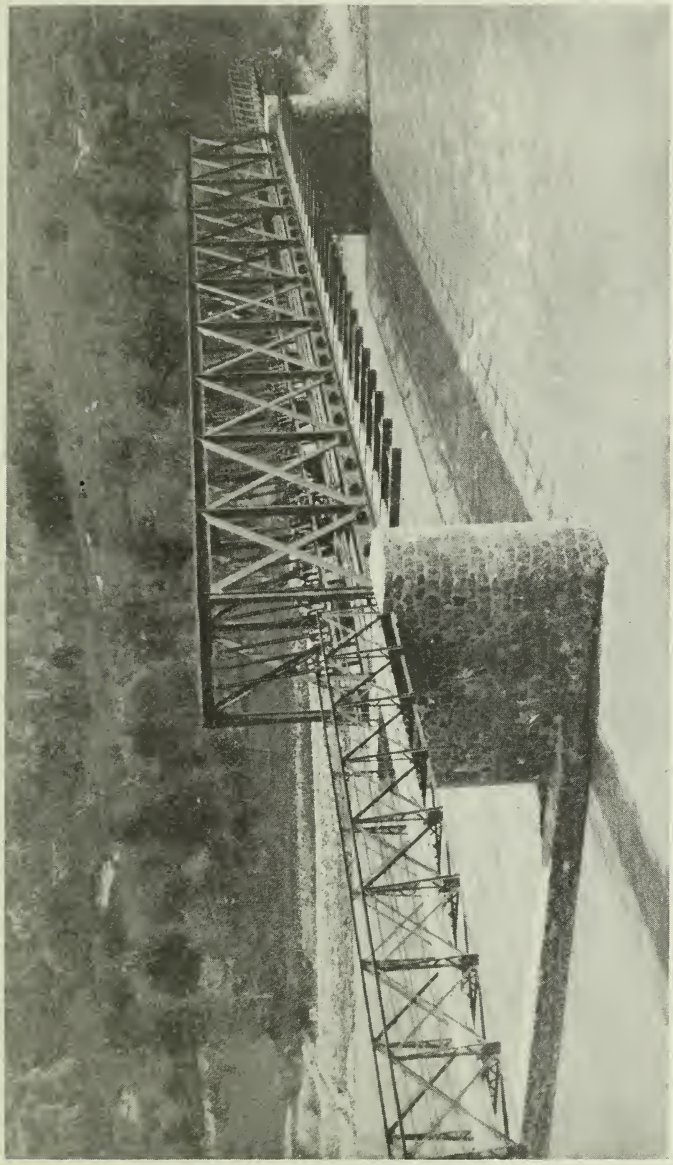
tion. The most interesting road I was over this summer really, was not a motor or, wagon road at all, except for a portion of the distance. This is amountain road from Kandersteg over the Gemmi Pass and down to Leukerbad, in the Rhone Valley. The portion down from the Gemmi pass on the Rhone Valley side is possible only for pedestrians and mountain horses and mules, being only about 5 ft. wide, and winds down the face of the cliff, a total drop of 1,800 feet in spiral after spiral, with many dizzy turns and unique views.

In hydraulics and water power Switzerland abounds in engineering examples. In the rivers there are many exceedingly interesting works in connection with the control of torrential and mountain streams, and in the rectification and canalization of some of the large rivers. Time will not permit to exxplain the devices which are employed in these works except to point out that by the proper arrangement of enbankments, training walls, submerged dams and groynes, it is extraordinary how water, even swift water, can be coaxed and directed and controlled in its various channels.

The modern water power plants of Switzerland have been operating for the past thirty years. They have always been ahead of us in the hydraulic and civil side of these developments, although I think now with our many new developments, especially in Canada, there is not much that they can show us any longer. They are, however, experts at economizzing water and making use of every pound of it and doing useful work. Some of these plants are, of course, in rivers in valleys, were the heads are low and where enough working head is obtained by dams or other contrivances, and used directly below the dam or through canals. Others are high heads, some of them up to 1,200 and even 2,000 ft., using a very small amount of water and operating large works or electric railways.

One sees power plants old and new in every direction and there is hardly a stream, especially in central and southern Switzzerland, which has not one or more power plants of various kinds on its route. There is a new plant now under construction on the Rhone River, a few miles below Geneva, which has a head of 25 ft., and will develop 43,000 h.p., which means a large body of water. There is a plant just finished not far from Berne with a head of 60 ft. and a capacity of 64,000 h.p., a large part of the water of which is from storage reservoirs and, in fact, this plant has a reserve capacity of 330 million cubic feet of utilizable water. Another large plant now under construction is being built not far from Martigny, in the mountains of the Rhone Valley, which when completed will operate a considerable section of the Swiss Federal Main line railways in the valley; this is under a very high head.

In Northern Italy the engineering work of the greatest interest is the hydro electric power. The development of the powers of these rivers has been going on steadily for the past twenty-five years and remarkable progress has been made. I visited many of these plants in 1906, most of which were then new. It was with considerable interest that I went back to see some of them when I was in Italy during the last year of the war. This past summer I had the opportunity also to visit some more, some of which were extensions of the former ones and some of which were entirely new. Perhaps the most interesting were those at Paderno, about 30 miles



Control Dam on Rhone River, Switzerland. Needle sluices are raised to allow flood to pass.

north west of Milan. I saw the original plant here on my first visit, and since that time there have been two extensions. The latest plant 40,000 h.p. under about 150 ft. head, has many new features, the result of experience in the interval. Hydraulically the interesting feature of this is the method by which they spill water at the end of the long canal which takes the water from the power station next above on the river. This water when not used in the station is spilled down a series of steps through automatic sluices in such a way that but little water passes without doing work.

The great system of hydro electric power development surrounding Milan and Tourin are exceedingly interesting, and form the greatest systems of the kind in Europe. These plants tributary to Milan now have nearly 150,000 h.p., this makes Milan a great industrial centre. These systems are similar to our Ontario system. The plants tributary to both these cities are of various types, both low and high heads, the high heads being in the mountains and the low heads down on the plains where the rivers come down on flatter slopes.

As an example of a river with continuous development by small power plants, I saw this summer for the first time a series of these in the Aosta Valley, where in some places they followed each other almost continuously, being used for municipal and industrial purposes.

It is interesting to talk to some of the prominent hydro electric engineers of Northern Italy with reference to the progress of these developments. I have a friend whom I have known for many years who is perhaps the most eminent hydro electric engineer in Italy. He had much to do with the Milanese plants, and he interested me very much with a discussion of the principle of the relation of the ice content of the glaciers in the mountains to the power output in the stations tributary to them. At first this sounds fanciful but is a very real thing, and it is a subject which we would do well to studysome day with reference to our own mountain rivers in the Canadian Rockies, in which, I myself, have had considerable experience.

Milan, as I have said, is mainly an industrial city, indeed, is one of the greatest cities of Europe in this respect, and there are many very interesting features of engineering of diffrent kinds which are worth giving time to if one were visiting there. The Italians are exceedingly ingenious and resourceful, and we have much to learn from them.

In conclusion, I have come home with many new impressions of the progress in the past few years in engineering in the different countries of Europe, and especially of the post war progress, if one may call it such. One is proud of the British and the British way of doing things. The outstanding features of British methods and practice not only in engineering but in everything else, reveal the strength of the Empire of which we are so proud to form a part. One is sure to be struck with the thoroughness and the solidity displayed in the great engineering works, and the methods of constructing and operating them which one finds in Great Britain. One derives from this great confidence and trust in the future of the British people and their quiet and thorough-going methods of carrying out their engineering projects and other activities.

ENGINEERING STANDARDIZATION*

By R. J. Durley, Secretary
Can, Engineering Standardization Association

The definition of the term "Standard" as given by Webster, is "that which is established as a rule or model by authority of public opinion or by respectable opinion or by custom or general consent."

Standards in engineering work, in conformity with this definition, should thus be the result of agreement as regards dimensions, methods of construction or qualities of material, such agreement being entered into by producers and purchasers for their mutual advantage.

The aim of engineering standardization, as we understand it, is to secure this agreement between producers and purchasers of engineering material, in order to effect economy and improve the product by eliminating unnecessary sizes and types of parts, or grades of material, or methods of testing for acceptance, thus securing interchangeability of parts, lessening the expense of production, reducing the amount of material kept in stock, and protecting the purchaser by ensuring standard quality.

It has been found advisable, by practically all of the existing standardization bodies, to arrange that work on a given subject shall onlly be undertaken on request from some responsible party. The essential features of such work are therefore expression of the need, full discussion between all parties interested, thorough investigation of the problem, the formulation of definite proposals, their criticism by the industries concerned, their amendments by discussion, and their final adoption by the authoritative central body.

The active support of the industries concerned is indispensable, and any idea of the compulsory introduction of standards is quite foreign to the scheme. Periodical revision of the standards decided upon is necessary to keep abreast of progress in the industries concerned, and care must be taken to avoid any decisions tending to limit unnecessarily, freedom and individuality in design. From time to time it is objected that the formulation of engineering standards may have the effect of stereotyping the product, thus hindering rather than facilitating progress and economy. There should be some force in this objection if, for instance, standardization were carried so far as to endeavour to get all firms to build to the same design in the case of a complete machine, or if there were no provision for periodical revision. The difficulty is actually taken care of in practice by the fact that owing to the absence of any legal or other compulsion, engineering standards are only adopted to the extent found advantageous by the industry, and a standard having the above mentioned defect would very soon lapse and go out of use. In dimensional standardization work accordingly, details of construction, rather than the completed machine, are usually dealt with, although in some cases advantage has been found in introducing standard types of machine, such, for example, as the standard types of locomotives used on the Indian railways.

It is obvious that standardization in the above sense does not include

* From an address to the Society, Nov. 14, 1923.

the very important work carried on under this name by such bodies as the International Bureau of Weights and Measures or the United States Bureau of Standards, nor does it deal with the formulation of any standards which require endorsement by legislative action.

The economic significance of industrial standardization has been well pointed out by Dr. Agnew, who in a recent address on the subject makes the following statement:

"If standardization is carried out on a sound engineering basis:

1. It enables buyer and seller to speak the same language, and makes it possible to compel competitive sellers to do likewise.

2. In thus putting tenders on an easily comparable basis, it promotes fairness in competition, both in domestic and in foreign trade.

3. It lowers unit-costs to the public, by making mass production possible, as has been so strikingly shown in the unification of incandescent lamps and automobiles.

4. By simplifying the carrying of stocks it makes deliveries quicker and prices lower.

5. It decreases litigation and other factors tending to disorganize industry, the burden of which ultimately falls upon the public.

6. It eliminates indecision both in production and utilization—a prolific cause of inefficiency and waste.

7. By focusing on essentials, it decreases selling expense, one of the serious problems of our economic system.

8. By concentrating on fewer lines, it enables more thought and energy to be put into designs, so that they will be more efficient and economical.

9. It stimulates research, to which it is closely allied.

10. It is one of the principal means of getting the results of research and development into actual use in the industries.

11. It helps to eliminate practices that are merely the result of accident or tradition, which impede development.

12. By concentration on essentials, and the consequent suppression of confusing elements intended merely for sales effect, it helps to base competition squarely upon efficiency in production and distribution and upon intrinsic merit of product."

It is interesting to note the intimate connection between engineering standardization work and industrial research, for in almost every case it will be found that during the process of developing or formulating an industrial standard, technical or scientific questions will arise which can only be settled by invesigation and research, the information gained in which is frequently of great benefit to the industry concerned.

The British Engineering Standards Association was the first central body to be established for the work of engineering standardization. It was founded in 1901, one of its earliest tasks being to obtain agreement and reduce the number of unnecessary sizes as regards standard sections for structural steel and rails as produced in Great Britain. The B.E.S.A. has now published nearly 200 reports and specifications, covering practically the whole field of engineering work, and its standards receive wide acceptance in Great Britain. The subjects dealt with, for instance, in-

clude such diverse items as cement, rolling stock material, forgings, electric meters, locomotives for Indian railways, incandescent lamps, electric cooking ranges, ball bearings, and a host of others. Since 1917 its activities have developed rapidly, and the scale of its operations is now such that it has over 400 working committees, with nearly 3,000 members. During the war the B.E.S.A. was able to render important technical service, especially in connection with naval and aircraft work. It was, for instance, called upon by the Air Ministry to organize committees and frame a series of specifications for aircraft material, which work was successfully carried out. In doing this, a large amount of research was initiated, especially in connection with novel methods of construction, the action of glue in glued joints and in ply wood, and innumerable questions connected with fabric for aeroplane wings and the action and kind of dope required.

An interesting feature in the work of the B.E.S.A. is the series of local advisory committees, established in Brazil, Chile, Argentina, India, South Africa, China and elsewhere, keeping the parent Association informed as to the industrial needs which develop in the various countries, and advising as to the suitability or otherwise of British Standards for local use. The C.E.S.A., though a completely independent body, has undertaken this duty as regards Canada.

In the United States, the movement began about the same time as in Great Britain, but was carried out individually by important technical societies, like the American Institute of Electrical Engineers, and the American Society of Mechanical Engineers, the former of which began its standardization work in 1898. In 1918, more than 100 American technical societies were engaged independently in engineering standardization work, but there were no systematic methods of co-operation, and in that year the American Engineering Standards Committee was organized to unify the methods adopted, to secure united action, and to avoid overlapping, serving also as a central cource of information and dealing with questions of international standardization. The A.E.S.C. is composed of representatives appointed by member bodies; it does not itself prepare standards, but receives and adopts those formulated by various sponsor societies. Its activity has led to rapid development in many directions, especially in connection with safety code work.

The American Engineering Standards Committee itself is composed of the representatives of a number of member bodies, including among others, the American Institute of Electrical Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers, American Society for Testing Materials, Society of Automotive Engineers, and various important departments of the United States Government. Such a Committee does not duplicate the work of other organizations, but acts as a clearing house for standardization and eliminates the duplication of work which has from time to time arisen in the United States.

On the Continent of Europe, national standardization bodies have been organized in Austria, Belgium, Czecho-Slovakia, France, Denmark, Germany, Holland, Hungary, Italy, Norway, Sweden and Switzerland. Action along the same lines has been taken in Australia, and Japan has appointed a standardization committee as one of its Government Depart-

ments. Many of the European Standardization bodies are extremely active, especially the powerful committee which has been formed in Germany. This, although only established in 1917, has already produced an amount of work equal, if not superior in volume, to that which has been done in Great Britain

The formation of the Canadian Engineering Standards Association in 1918 took place as a result of suggestions put forward by the B.E.S.A., and our constitution follows generally that of the B.E.S.A. The work of the Association is directed by a Main Committee of over 40 members, prominent in industrial and scientific work. Sectional Committees are appointed, each dealing with one of the main divisions of engineering work, and the actual technical work of the Association is accomplished by Sub-Committees, each of which deals with one specific task. There are at present 13 Sectional Committees and over 40 other working committees engaged in the discussion of the standards which are now in preparation.

The Association is supported by subscriptions from technical societies and firms interested, together with a grant from the Dominion Government.

As an example of the way in which our Canadian standardization work is done, it may perhaps be of interest to take the case of galvanized telegraph and telephone wire, which was one of the first to be dealt with by a Canadian Committee of the C.E.S.A.

A request from one of the largest manufacturers of this material was placed before the Main Committee in 1919, and indicated that line-wire was being purchased in Canada to a large number of specifications, differing very slightly among themselves, but varying to such an extent that it was impossible for wire rods to be rolled or for wire to be drawn for stock with the certainty of being acceptable to more than one of the large telephone or telegraph companies. It was pointed out that if two or three grades of this material could be agreed upon as fulfilling Canadian reqnirements, considerable economy would result and material could be promptly obtained from stock. A Sub-Committee was accordingly appointed to deal with the question, of which representatives of all the manufacturers and all the telegraph and telephone authorities were members. After a preliminary comparison of the existing specifications and the preparation of a draft for criticism, two meetings of the Committee were held at which it was agreed that the C.E.S.A. Specification for Galvanized Line Wire should cover two qualities of wire and five sizes in each quality. The resulting specification was approved for publication in February, 1921, and is receiving general adoption. The saving resulting from the complete adoption of this specification by all concerned is estimated at from 75c. to $1.00 a ton on an average consumption of eight to ten thousand tons per year.

A list of the publications of the C.E.S.A is as follows:—

No. A1-1922 Standard Specifications for Steel Railway Bridges.
No. A1a-1922 Material Specifications, Steel Railway Bridges (Separate reprint).
No. C2-1920 Standard Requirements for Single-phase Distribution Type Transformers.

No. C3-1921 Standard Specifications for Galvanized Telegraph and Telephone Wire.
No. B4-1921 Standard Specification for Wire Rope for Mining, Dredging and Steam Shovel Purposes.
No. A5-1922 Standard Specification for Portland Cement.
No. A6-1922 Standard Specification for Steel Highway Bridges.
No. D7-1922 Standard Specification for Flexible Steel Wire Rope and Flexible Strand for Aircraft Purposes.
No. G8-1923 Standard General Specification for Commercial Bar Steels.
No. A9-1923 Standard Specifications for Reinforcing Materials for Concrete.
No. C10-1923 Standard Specification for Regular Tungsten Incandescent Lamps.

SHOP MEASUREMENTS*

By Major Earle Buckingham

I wonder if any of us fully realize the important place which measurements hold in all of our activities. A measurement implies a comparison with some standard. Thus, if we stop to think, our opinions of our friends and acquaintances are based on a comparison, or measurement, with certain ideals. All trade and commerce depend upon measurements of quantity or quality against measurements of value. Also all exact human knowledge is developed from measurements of some sort or other. This afternoon I visited your hydraulic laboratory and saw many of you making tests. All this data that you recorded for the purpose of determining the performance of the apparatus under test were measurements.

In machine shop practice, also, measurements are one of the fundamental processes. In fact, the accuracy to which we can work depends upon the accuracy to which we can measure. The mere removal of material from the part under construction is seldom in itself a difficult task. The critical point is knowing when to stop. This point can only be determined by measurement.

No measurement is ever absolutely correct; some factor of error is always present. Accuracy is a relative term. For example, an astronomer may make an accurate determination of the position of a star. His measured distance may vary from the actual distance a million miles or more. Nevertheless, his determination is accurate. Going to the other extreme, a physicist engaged in making measurements of the length of light waves must have his determination correct to within a fraction of a millionth of an inch in order to be accurate.

In machine shop practice a definite dimension is specified. When developed in metal, we may never get that exact dimension, but a more or less accurate approach to the specified size. If we keep this fact in mind, it will do much to clarify the matter of proper dimensioning.

Most shop measurements are measurements of length. These measurements are expressed in terms of some unit of length; with us usually the yard or its subdivisions. All units of length are arbitrary distances in space defined by the length of some specified bar of metal under specific conditions of temperature, etc. Efforts have been made to define these units in terms of some natural phenomena, but ultimately it was found necessary to rely on aspecific bar of metal. For example, the effort was made to define the yard as the length of a pendulum with a definite period of oscillation. This was found impractical. The effort was made to define the meter as a definite part of the earth's quadrant, and this also was found impractical. In both cases the size of such a defined unit of length varied as improved and refined methods of making the necessary observations were developed. It is obvious that a fundamental unit of length which is subject to any appreciable variation will create much confusion, and be practically worthless. In both of the foregoing cases, the fundamental unit of strength was eventually defined as the

* From an Address before the Society, Jan. 30, 1924.

distance between two fine lines graved on gold plugs in a bronze bar at specific temperatures.

After a fundamental unit of length has been accepted, it is necessary to adopt some common practice in regard to its application to various types of measuring instruments in order to maintain uniformity among them. A metal measuring instrument can represent a specified abstract length only at one specific temperature. Hence if one bar duplicates the abstract length of a yard at 60° F., while another duplicates it at 70° F., the two bars when compared with each other at the same temperature will vary. The bar which is standard at 70° F. will be shorter than the one which is standard at 60° F. The practice in this respec' is quite different with metric units of length as compared with English units of length, so that space will be taken here to treat each system of measurement in some detail.

English Standards of Length

The fundamental English standard of length of one yard is the distance between two fine lines graved on gold plugs in a bronze bar at Westminister, when this bar is at the temperature at 62° F.

Copies of this fundamental yard made for general use are calibrated against the original bar, and any observed differences are noted in one of two ways. First, the measured difference between the two bars when both are at 62° F. may be given. Second, the temperature of the copy may be varied until both bars are of the same length. Then this second bar is calibrated as having the correct length when at the altered temperature, such as 63° F. for example.

When such calibrated bars are used in other comparisons the necessary correction is made, either by compensating for the known difference in length at 62° F., or by keeping the calibrated bar at the corrected temperature, and the measured bar at its desired temperature of calibration.

Any standard with a definitely known error is practically as good as a perfect one, as such known errors can be compensated for. This is especially true of primary standards which are used to calibrate the industrial measuring instruments, where such calibrations are made in laboratories where the temperature conditions are carefully controlled.

For general industrial uses, such extreme refinements are not necessary. As long as the limit of error of measurement is kept well within the probable error of execution in the production of the parts to be measured, industrial measuring instruments are sufficiently accurate.

For purposes of uniformity, it is desirable that all industrial measureing instruments be nominally of correct size when at some common temperature. Furthermore, as not only these measuring instruments, but also parts measured by them may be made of different materials with different coefficients of expansion, it is most desirable that this common temperature be one approximating the average working temperature at which such instruments are ordinarily used.

At the present time, two different temperatures at which measuring instruments for English units of length are nominally of correct length, or standard, are used. These temperatures are 62° F. and 68° F.

The temperature of 62° F was originally used because it was the

temperature at which the fundamental standard yard bar is of correct length.

The temperature of 68° F (20° C) is rapidly gaining in favor in the United States, because it more nearly represents the average working temperatures; because it has also been widely adopted as a standard temperature for many other physical tests; and because it is exactly equivalent to an even Centigrade temperature, 20° C. This temperature has been used exclusively in this country for the past ten years in all gage standardization.

Metric Standards of Length

The fundamental metric standard of a length of one meter is the distance between two fine lines graved on a platinum iridium bar at the International Bureau of Weights and Measures at Sevres, France, when this bar is at the temperature of 0° C.

Copies of this fundamental meter, of duplicate construction and materials, have been made, calibrated against the original, and distributed to the several countries subscribing to the International Bureau of Weights and Measures. These copies are numbered and known as Prototype Meters. The prototype meters Nos. 21 and 27 are held in this country at the Bureau of Standards atWashing ton. These bars are nominally of correct length at 0° C.

For general industrial use, at the present time two different temperatures at which metric measuring instruments are nominally of correct length are used. These temperatures are 0°C and 20°C (68°F).

The temperature of 0° C (32° F) was originally used because it was the temperature at which the fundamental standard meter bar is of correct length; and because this temperature, the melting point of ice, could be more exactly duplicated and maintained than any other. The great difference between this calibration temperature and the ordinary working temperatures at which such instruments are used introduces a complication. Instruments made of different materials with varying coefficients of expansion which would measure alike when at the temperature of 0° C would show measurable differences when used at the ordinary working temperatures, because of their differences of expansion. To overcome this difficulty, the Director of the International Bureau of Weights and Measures recommend the following practice:

Gages and other measuring instruments used in the manufacture of metal parts should be so made that when calibrated at 20° C they have an assumed coefficient of expansion of eleven millionths per unit of length per degree Centigrade. In other words, at 20° C, the actual length of such standards will be 220 millionths per unit of length longer than the corresponding subdivision of the fundamental standard of the meter at 0° C.

This recommendation is eminently practical, and the recommended practice is widely used, particularly in France. The majority of measureing instruments used in the metal-working trades are of steel. The coefficient of expansion of cast iron and steel, the most commonly used materials for parts of any appreciable size, varies from about ten to twelve millionths per unit of length per degree Centigrade. Thus the temperature of 0° C

at which the parts nominally have their specified abstract length is maintained closely enough for alll practical purposes. On smaller parts made of other materials, the theoretical error introduced by this practice is very slight, as it depends upon the difference between their actual coefficient of expansion and the arbitrary one of eleven millionths. For scientific work in laboratories such differences must be considered, but for all practical purposes in the machine shop, they may be ignored.

The temperature of 20° C (68° F) is widely used, particularly outside of France, because it more nearly represents the average working temperatures; because it has also been widely adopted as a standard temperature for many other physical tests; and because it is exactly equivalent to an even Fahrenheit temperature of 68° F. This temperature has been adopted as standard for all gages and other industrial measuring instruments by the engineering standardizing bodies of Sweden, Holland, Switzerland, and Germany. In this case the lengths of the measuring instruments when at the temperature of 20° C are the same as the corresponding subdivision of the fundamental standard of the meter bar at 0° C.

In general, shop measurements may be divided into two general classes; direct and comparative. A direct measurement is one where the attempt is made to determine the actual, or absolute size. A comparative measurement is one where the attempt is made to determine the difference in size between similar or mating parts. A comparative meausurement is not only easier to make than a direct one, but smaller differences can also be detected. For example, a mechanic given several plug gages of the same nominal size can readily grade them as to their respective size with a pair of spring calipers even when the actual difference in size is so small that it cannot be measured with a micrometer.

Purposes of Shop Measurement

The purpose of shop measurement is to control the sizes of the parts being manufactured. Every size of every surface is measured in some manner. Many times, on experimental work for example, no attempt is made to hold the various surfaces to any exact predetermined size, but the mating surfaces are fitted to each other. In such cases, the first surface finished becomes the measuring instrument for its mating surface.

Shop measurements are essential in all stages of production. Parts made individually are first layed out. This operation is identical in many respects to the layout or drawing made on paper. In the case of a drawing, the measurements are all made in one plane. The layout on the metal parts, however, requires measurements in several planes. The making of all such layouts is essentially a matter of measurement.

As the machining operations progress, measurements must constantly be made. As stated before, the mere removal of material from the part under construction is seldom a difficult task. The essential thing is knowing when to stop.

After that part has been completed, measurements are required to insure than the desired results have been attained. Such measurements may be direct ones, checking their measured dimensions against the specified ones; or they may be comparative ones made by assembling the parts and judging them by the resulting assembled conditions.

Before any shop measurements can be effectively made, three questions must be answered. First: What shall we measure? Second, Why should that measurement be made? And Third: How shall we measure it? Too often the second question is ignored, often with the result that indirect and complicated measurements are made that have but little effect on the control of the essential sizes that should b maintained. The real science of shop measurements lies in knowing what and why to measure rather than in knowing how to measure.

The problem of proper shop measurements is closely allied to the problem of proper dimensioning of drawings. A fundamental law of dimensioning is that dimensions should be given between those surfaces which it is essential to hold in a specific relation to each other. If all drawings rigidly adhered to this rule, in most cases the problem of shop measurements would resolve itself into the problem of how to measure the dimensions shown on the drawings. Unfortunately very few drawings comply with this law in all respects. Too often the position of the dimensions on the drawing is governed more by the convenience of the draftsman rather than by the essential inter-relation of the surfaces dimensioned.

To a great many people, the purpose of measuring is to see that the parts as made agree with the drawing. This is not their true function, however. The main purpose of measurement is to prevent unsatisfactory parts from being produced. The testing which may be done later is but a supplementary check on the work accomplished. Measurements, or inspection, to be most effective should be used as a preventative, and not a cure. The time to prevent errors is when the metal is being shaped to size or form, and not after the work has been completed. The object of measuring or inspection after individuaal machining cuts or entire pieces have been completed is to insure that all parts which will function properly are accepted and that all parts which will not, are rejected as soon as the defect exists, to save the expenditure of further effort on useless parts. When the drawings truly and definitely record the requirements of acceptable parts, they may safely be adhered to. Until then, they will either be ignored in part at least, or else unnecessary expense will be incurred in the production of the parts.

When the question of "Why should that measurement be made? is asked, and the answer is that there is no particular reason why it should be made for any purpose, it is evidence that the dimension in question should not be on the drawing. If the point or surface in question is not dimensioned from any other point, a search should be made for its most essential inter-related surface, and its measurement should be determined from there. If it should already be dimensioned from there also, the first dimension is not only superfluous but also misleading, because if care were not exercised, the position of the surface in question might be established from a non-essential register point instead of from the really essential one.

If all measuretments were absolute, it would make little difference, perhaps, how the various positions were determined. But as they are not absolute, this matter of what measurements are made becomes of vital importance. The probabilities are that if two measurements are made to determine a position where one measurement would answer, that double

the variation will be present; if three are made, triple the variation, etc. This holds true whether the measurements are made to determine when to stop the removal of metal or to determine the finished size. In the case where the proper functioning of the surfaces in question requires a definite degree of accuracy between certain essential surfaces whose positions are thus indirectly controlled, it results in the necessity of a far higher degree of accuracy—which is always expensive—in the machining and measuring of several supplementary surfaces than is actually required between the two essential surfaces. This increased degree of accuracy required will be in direct proportion to the number of supplementary measurements made to control the essential dimensions, and the cost of maintaining these supplementary surfaces to the unnecessary degree of accuracy thus demanded will increase far more rapidly.

One fact should always be kept in mind. A high degree of accuracy is very expensive and does not always serve any useful purpose. Any surface should be held to that degree of accuracy truly required, and no closer. Every functional surface of a mechanism has more or less definite limits of size within which it will operate propertly. In some cases, the extent of the permissable variations is very small; in many other cases it is relatively large. No useful purpose is served in arbitrarily hollding all variations to extremely small amounts regardless of the conditions to be met. The object of manufacturing is not to see how closely certain sizes can be held, but rather to produce various commodities as economically as possible.

Where repetitive work is involved, it is customary to make up various types of work-holding devices, such as jigs and fixtures, to facilitate the several machining operations on the component parts of the product. Any errors which exist in the essential parts of these work-holding devices will also be present in the product which is produced from them, in addition to the unavoidable variations which develop in making the machining cuts. Therefore the errors in the functional or locating elements of such equipment should be kept to a minimum. In such cases, the expense of a relatively high degree of accuracy is justified because it is incurred but once for the benefit of all future production on this equipment. Furthermore, appreciable inaccuracies in this equipment requires a higher degree of accuracy in all operations performed with its aid than would otherwise be required. In work of this class, the degree of accuracy sought should be the highest degree that can be reasonably attained.

These same considerations as regards accuracy hold true to a somewhat lesser degree for cutting tools which control the size or form of any finished surface. If the life of such tools were as great as the life of the jigs and fixtures, the expense of the same degree of accuracy would be justified. Usually, however, their life is very much shorter. The economical degree of accuracy required is therefore governed largely by the degree of accuracy required on the product, and the increased expense of a higher degree of accuracy on the part of the cutting tools as compared with the decreased expense of producing parts to the required limits with the more accurate tools. In general, the amount of variation permitted on such perishable tools should be not less than half the total variation permitted on the product.

The whole problem of permissible variations, or tolerances, is a very vital one, involving not only the manufactured product itself, but also the tools and other equipment used to produce it. If the tolerance specified are closer than are actually required, unnecessary expense will be incurred in meeting them; if they are too liberal, an unsatisfactory product will result.

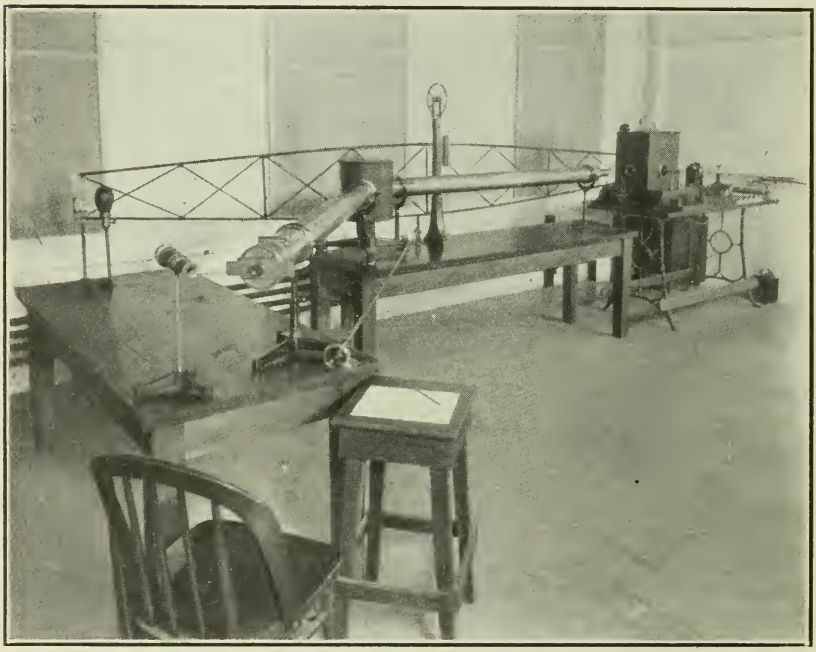


Fig. 1. Interferometer

There is a limit to a degree of accuracy which can serve any useful purpose in machine shop practice. For example, a difference in temperature of several degrees often exists between a part as it is just completed, and still somewhat warm from the heat of the cutting operation, and one which has been completed for some time and has cooled to room temperature. Also a somewhat similar difference in temperature often exists between a measuring instrument which has been held in the hand for some time, and parts which are being picked up and measured successively. This difference will often amount to fifteen or twenty degrees, and some times even more. The difference in size due to expansion by heat of this amount will be about one-tenth of a thousandth of an inch per inch of length. It should be obvious that with such variations due to temperature

present, that the relative sizes of similar parts under these conditions cannot be controlled to the tenth of a thousandth. Whenever the degree of accuracy required is less than one-quarter of a thousandth of an inch per inch of length, suitable precautions as regards the temperature must be taken. Whenever it begins to approach the tenth part of a thousandth of an inch, per inch of length, or less, the determinations must be made in a controlled temperature room, and many other precautions must be taken, if dependable results are to be obtained.

An interesting development in the past few years is the use of light waves for determining lengths. This has been used for almost thirty years by scientists in the laboratories, but it is now used commercially to establish sizes of accurate gages. This method enables sizes to be determined within a limit or error of two or three millionths of an inch.

In Fig. 1 is shown an interferometer, which is used to make light-wave measurements of a standard. This instrument consists of the source of light, in this case a neon gas tube, the lens which focuses the light on the interferometer plates, the constant temperature box which contains the interferometer plates, and the block to be measured, and the spectroscope.

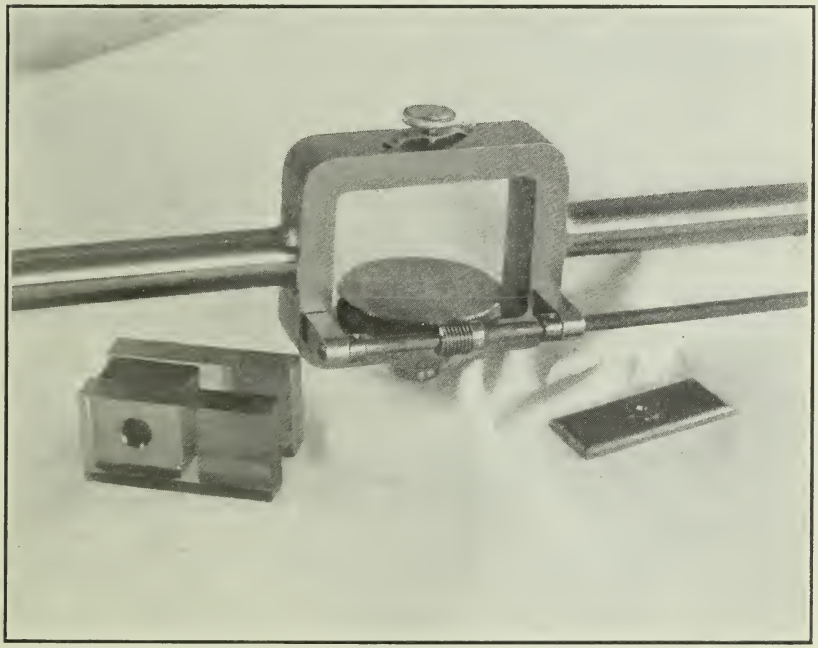


Fig. 2. Interferometer Detail

Fig. 2 shows the interferometer details. The interferometer plates are two optical flats, which have a thin transparent coating of gold on one

end to increase the reflective power. This gold film is a fraction of a millionth of an inch thick. The standard to be measured is wrung beween the two glass plates and is placed on the holder. This holder is so designed that the position of the plates can be adjusted from outside the constant temperature box to bring them into proper alignment with the optical system.

The constant temperature box contains a tube into which the interferometer plates are placed with an intersecting tube through which the light passes. These tubes are surrounded by a liquid bath which is kept at a temperature constant within about one-tenth of a degree Centigrade, by means of cooling and heating coils which are controlled by a thermostat. This liquid is kept in constant motion by a propeller blade to insure a uniform temperature throughout the bath.

When the light passes through the gold films on the interferometer plates, it is reflected back and forth between them, thus making interference fringes or rings. A slit at the front of the spectroscope tube permits only a thin segment of these rings to pass through the prism set at the intersection point of the two long tubes. A fine cross hair is mounted in the eyepiece at the end of the second tube, and the interferometer plates, or etalon, is rocked by means of the long trus lever until one of the bands of light of one of the lines of the spectrum is bisected by this cross hair. The angular position of the long lever is then noted, and the lever is rocked until the corresponding band on the other side of the center of the interference ring is in a similar position. This gives the angular measurements of the chosen ring. Similar measurements are then made of two or three other lines of the spectrum. As these bright bands only occur when the length along the cone of the light rays between the two interferometer plates is an integral number of light waves long, these measurements give us simultaneous equations with one factor missing. To solve these equations, a value is assumed for the number of light waves in one of them. If all the other equations come out even intergers, the assumed value is correct. If not, another value is assumed and the process repeated. As a general rule, the correct interger is found in about three trials.

As a further precaution, several complete set-ups are made on each block measured. Three of such readings must check within two millionths of an inch before the measurement is accepted.

It takes about two hours to make a measurement on this apparatus. Most of this time is consumed in waiting for the block to come to temperature. Readings are taken periodically to determine if the block has come to rest. When no change can be detected after fifteen or twenty minutes, the block is practically to temperature, and the measurement is then made.

MODERN STEAM POWER GENERATION

By Robert W. Angus, Professor of Mechanical Engineering.

During the past ten years or so many improvements in the economical generation of power by steam have been made and a brief discussion of some of these developments is presented herewith.

At the beginning of the last century the valuable work of James Watt had begun to be felt, and it is interesting to note that he and some of his contemporaries had discovered the use of the piston engine with crank and fly wheel, the use of the condenser, the advantages of higher pressures, and compounding, and had, in fact, many of the devices known at the present time. Watts' use of the indicator also made it possible for a somewhat careful study of the action of the engine to be made, and thus work towards higher economy. The earlier builders, however, were not equipped with the high-grade accurate machine tools and equipment available in even a very modest shop of the present day, and consequently the steam consumption of their engines was high, due in some part to loosely fitted pistons and rods, large clearances, etc.

While Watt recognized the lines along which progress might be made, it remained for Sadi Carnot to formulate, in a work published exactly one hundred years ago, the ideal method of working all heat engines, and he showed that such engines never can have efficiencies approaching unity. To describe Carnot's work in a few sentences is difficult, but he laid down the principle that the efficiency of the ideal or perfect heat engine depends on the temperatures of the supply and exhaust, and it is readily shown that this ideal efficiency is equal to the difference between these limiting temperatures divided by the absolute temperature of the supply. Carnot further stated that whether steam, gas or any other fluid was used in the engine was immaterial so far as its possibilities with given limiting temperatures was concerned.

Thus, if the maximum temperature available for the supply is 600°F, and the exhaust temperature is 80°F. the limiting efficiency for any engine, irrespective of the type of fluid used, would be $\frac{600-80}{600+460}=49\%$ although, of course, the actual engine would be considerable below this. Carnot also showed that whatever heat was being delivered to the heat engine should be added at constant temperature and the exhaust should be taken out under similar conditions.

Steam engines have been able to approximate most of the process described by Carnot as corresponding to the maximum efficiency, because where saturated steam is admitted to the cylinder the pressure is constant, which also means the heat is carried in at constant temperature, the steam may then be expanded in a cylinder so as to roughly approach the non-conducting process of Carnot, it is then exhausted at constant temperature, and if it could be returned to the initial temperature by compression in a non-conducting cylinder the process would be ideal. Unfortunately, the last event is not possible, and the fluid must be returned cold to the boiler, raised in temperature and evaporated there, and it is this part of

the process primarily that prevents the realization of the ideal efficiency of the actual cycle.

In order that engine efficiencies might be compared with those which were possible in the process as actually carried out, Rankine later established a cycle in which the first three parts were the same as in that of Carnot, but the last part corresponded almost exactly with the processes actually used in the air and feed pumps and boiler. The cycle of Rankine naturally has a lower efficiency in the ideal case than that of Carnot, but has been used for years as a standard because of its seeming practical bearing.

With these preliminary statements we may now discuss the present and future possibilities of the steam engine. The statement established by Carnot that the possibility in the way of efficiency depends on the range of temperatures, and also on the temperature at which the heat is supplied, has led engineers to try to improve the efficiency both by raising the temperature of the steam supplied and also by lowering the tmperature of the exhaust. The latter temperature depends on the condenser, and on the vacuum maintained there, and there appears to be no chance of lowering this very much, for while temperatures slightly over 60°F have been reached with a vacuum of nearly 29½ in., yet the ordinary practical limit can scarcely be much below 80°F, which corresponds to 29 in. vacuum.

Improvement in this direction must, therefore, be obtained by raising the temperature of the steam supplied, and, assuming satisfactory materials, this may be carried on to almost any degree. Two methods have been employed, viz.: (a) increasing the pressure and maintaining saturated steam, (b) producing superheat without materially raising the pressure. As far as the perfect engine in the ideal Carnot cycle is concerned, it makes no difference which method is used so long as the temperatures are obtained, but when the actual cycle is considered in the form stated by Rankine, it is quite easy to show that it is better to maintain the steam saturated and obtain the temperature by raising the pressure.

The following results, Tables I. and II., illustrate the point fairly well:—

TABLE I

No.	Pressure absolute pds. sq. in.	Temperature Steam °F	Heat Contents per lb. Sat. St. B.T.U.	Heat Contents per lb. of St. Superheated B.T.U.	EFFICIENCIES %			
					Saturated		Superheated	
					Rankine	Carnot	Rankine	Carnot
				at 700°F				
1	300	417	1202	1369	34	39	36	53.5
2	600	486	1200	1349	37	43	38	53.5
				at 450°F				
3	422	450	1201	.....	36	41	....	....
4	200	482	1198	1240	....	....	32	41

The first two cases in Table I. show that it takes slightly less coal to produce saturated steam at 600 pds. than at 300 pds., although the former shows the higher efficiency on both cycles. If in both cases the steam is superheated till it reaches 700°F, there is a clear saving in coal at the higher pressure but only a very slight gain in Rankine cycle efficiency and the ratio of the Rankine cycle result to the ideal of Carnot shows a very marked decrease with superheated steam. Also the less the superheat the higher the efficiency.

In cases 3 and 4 steam at 450°F is produced, in the first case as saturated steam at 422 pds., and in the second case as steam at 200 pds. superheated 68°F to a final temperature of 450°F. Both kinds of steam require the same amount of coal to produce them, but the saturated steam shows four per cent. higher efficiency on the Rankine cycle.

TABLE II

Absolute Pressure pds. sq. in.	Saturation Temp. °F	Heat Contents per Pound, B.T.U.			
		Saturated Steam	Superheated Steam		
			400°F	500°F	600°F
100	327	1188	1227	1280	1330
200	383	1198	1209	1268	1322
300	420	1202	.....	1256	1314
400	447	1203		1241	1304

These results are farther shown in Table II., which is well worthy of study. This table shows that it only takes 1.5% more coal to produce saturated steam at 400 pds. than at 100 pds., and it further shows that the amount of coal decreases as the superheat decreases.

Thus if steam is required at 600°F, it can be produced at 100 pds. and superheated 600—327=273°F, in which case there would be required 1330 B.T.U. If, however, this steam is produced at 400 pds., with a superheat of 600—447=153°F, the amount of heat required will fall to 1304 B.T.U. and this shows again the importance of using high pressures and low superheat.

The above results are shown on Fig. 1, where it is very clear that with the Rankine cycle saturated steam at any given temperature shows a higher efficiency than superheated steam at the same temperature. The tendency toward higher pressures, then, is evident, and superheating will only be done sufficiently to prevent condensation in the turbine blading, which is very destructive and causes considerable loss in friction.

Reheating

Reheating of steam in engines has long been practised, although the plan has not been adopted in turbines. In steam engines it has usually been done by using a part of the working steam in the jackets and frequently also in the receivers between the cylinders. This practice was common in high-duty slow-speed engines working at uniform load, such as pumping engines, and in these over fifteen per cent of the steam delivered to the engine does not go into the cylinders, but is used in the jackets, etc.,

and yet these machines have the very highest efficiency. Reheating is now under consideration with steam turbines, and theoretically it shows a gain, although little can be said about it at present. It is rather more difficult

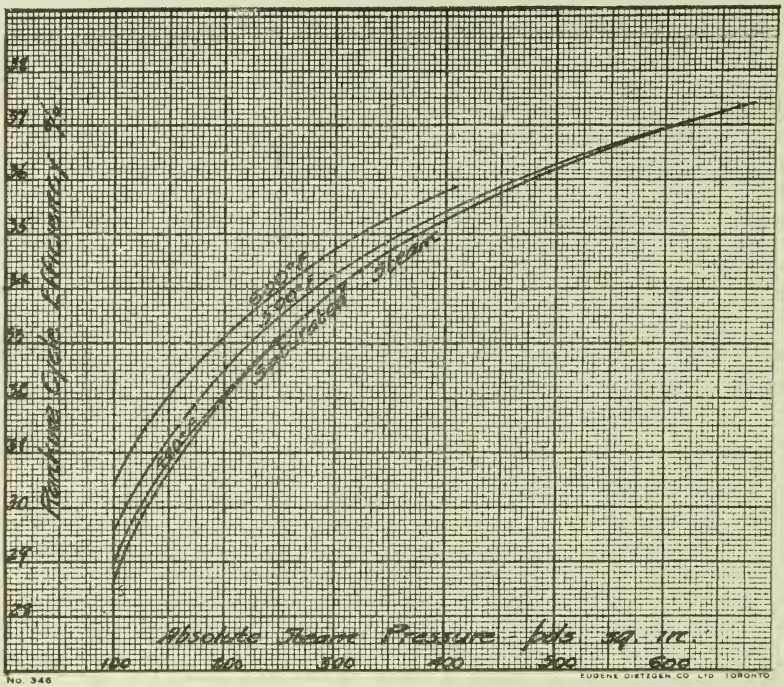


FIG. 1.

of application in turbines than in engines and does not seem to give so much promise, but further development is awaited with interest.

Bleeding of Steam from Turbines

Within recent years successful efforts to increase the efficiency of turbine plants have been made by the process of bleeding steam from the main turbines at different points and using this steam to heat the feed water. This multi-stage feed water heating process is similar to that adopted by Ericsson in the air engine many years ago, and at first sight it would seem very wasteful to use steam at high pressure to heat the feed water.

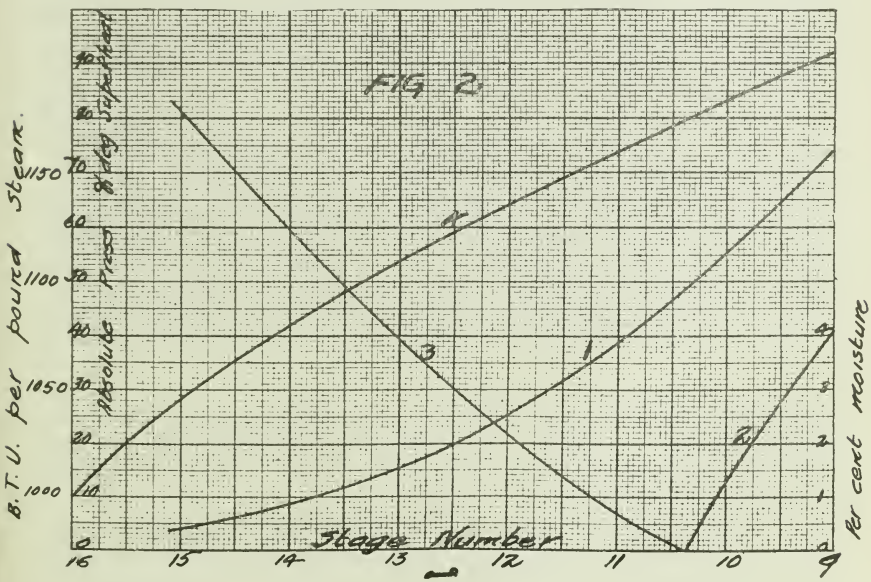
Lack of space prevents full discussion of this point, but it may be very readily shown that the above process has very great promise, and that where saturated steam is used, if steam is drawn from every stage of the turbine, *i.e.*, at every pressure between the boiler and condenser pressures, and if the amount of such steam is carefully adjusted, and this steam used with proper equipment to heat the feed water, then the temperature of the feed may be that of the live steam, and further, the possible efficiency of the machinery will be that of Carnot's cycle, or as great as that of the ideal engine.

Bleeding the turbine for feed water heating is therefore most promising in its effects, and the process is actually being used in some of the best plants to-day, although so far the steam is drawn off at only from one to four points, and separate heaters in series are used for each point where the turbine is tapped.

The case may be mentioned of the Hell Gate station of the United Electric Light and Power Co., where bleeding is done from the 12th and 17th stages of a 40,000 K.W. unit. When this unit is developing 35,000 K.W. the guaranteed steam consumption is 10.65 lbs. per K.W. hour, or a total of 372,750 lbs. per hour, and under this load 25,000 lbs., or 6.7%, of the steam is drawn off at the 12th stage, where the pressure is 54 pds. absolute, and in addition 34,000 lbs. or 9.1% is drawn off at the 17th stage at an absolute pressure of 6.8 pds., that is, nearly 16% of the steam is drawn out of the turbine for feed water heating.

In the Colfax Station, near Pittsburg, bleeding is being done at four points in the 60,000 K.W. turbines, and as the plan is relatively new, farther development may be looked for.

Some interesting information on this point has been presented by Mr. G. G. Bell of the West Penn Power Co. in the Transactions of the American Society of Mechanical Engineers, Vol. 44, in which he has



worked out the results of various methods of extraction from a 30,000 K.W., G.E. turbine working at 28,000 K.W. load with steam at 300 pds. and 200°F superheat and 29 in. vacuum.

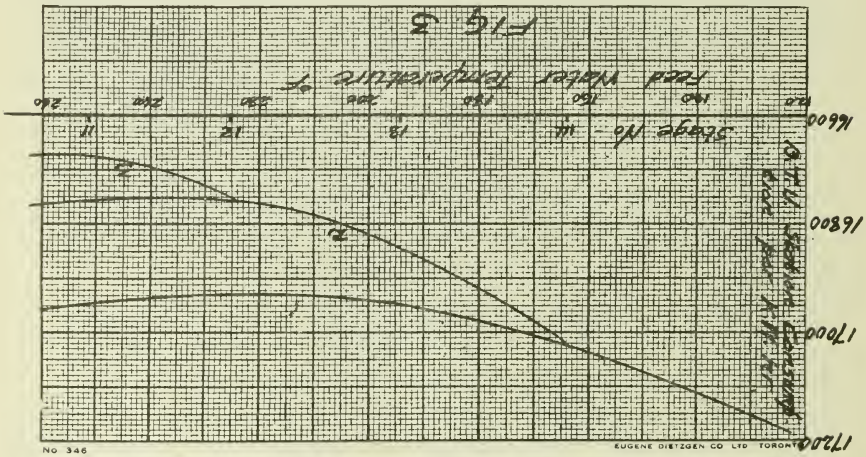
Fig. 2 contains a set of curves showing (1) the pressure (absolute)

at each stage, (2) and (3) the degrees superheat and moisture respectively in the steam, (4) the B.T.U. contained in each pound of bled steam.

The next figure, Fig. 3, shows the B.T.U. per K.W. hour consumed by the station under different conditions of bleeding. Thus curve (1) shows the effect of single stage extraction at any one stage, with the corresponding feed temperature and the best results will be obtained for conditions giving feed temperature of about 220°F where two-stage bleeding occurs, at the 14th and higher the B.T.U. per K.W. hour drop from 169,200 to 16,750 with a somewhat higher feed temperature of 240°F. In curve (3) with three-stage bleeding, the extra stage being No. 12, the B.T.U. are 166,800 and feed temperature 270°F, and so on for further combinations.

Mercury Turbines

Considerable interest has been aroused over the mercury turbine invented by Mr. W. L. Emmett and recently tried at Hartford. The earlier part of this paper emphasized the value of high temperature saturated vapour over superheated vapour at the same temperature, but high



temperatures with steam mean high pressures, and these again mean much stronger apparatus. Further, low temperatures of steam mean very low pressures and the present equipment does not allow the use of anything much below about 80°F.

To obviate these difficulties and still obtain high efficiencies, the use of two or more fluids, operated in series, has been suggested, and Mr. Emmett has employed mercury and steam to cover the upper temperatures, to which some inventor may add a fluid like ammonia for the lower part of the temperature scale. Mercury vapour at 810°F has a pressure of only about 50 pds. absolute and at 29 in. vacuum a temperature of 414°F, whereas saturated steam at 400°F has a pressure of 247 pds. and at 29 in. vacuum a temperature of 80°F. The figures on mercury

vapour are largely taken from articles by Kearton in "Engineering," Nov. 1923.

If now a boiler is made with a suitable condenser and turbine in which mercury is the working fluid instead of water, the working pressure to be used would only be 50 pds. absolute for a temperature of 810°F, and if the exhaust from this turbine at 29 in. vacuum and 414°F passes into a surface condenser with circulating water it is evident that it could heat this water to about 400°F and make steam at the same temperature, which is 247 pds. absolute.

Accurate tables of the properties of mercury are not at hand, but taking approximate figures and assuming the vapour saturated and working in an ideal cycle, the results would work out about as follows:—

100 lbs. mercury at 50 pds. absolute, temperature 810°F, contain $100 \times 152 = 15{,}200$ B.T.U., and if expanded in an ideal cycle to a vacuum of 29 in. would correspond to a heat drop of $42 \times 100 = 4{,}200$ B.T.U., the temperature at 29 in. vacuum being 414°F. If this hot mercury is run into a condenser or boiler containing water, it could raise steam at 400°F or 247 pds. pressure absolute. The heat available in the mercury would be the latent heat of the vapour after expansion, and is approximately $152 - 42 = 110$ B.T.U. less the heat of the liquid mercury at 414°, leaving only $97 \times 100 = 9{,}700$ B.T.U., taking the specific heat of mercury as .033. This amount of heat could produce $9{,}700 = 8.42$ lbs. of saturated steam at 400°F from feed

N.B. $9{,}700/1.150 = 8.42$
$\quad\quad 1{,}150$

water at 80°F.

Assuming the 8.42 lbs. steam so produced to work in an ideal cycle with a vacuum of 29 in. they would make available $382 \times 8.42 = 3{,}210$ B.T.U. for work. The exhaust from this engine might next be used on ammonia, etc.

Taking the example just quoted and assuming that 100 lbs. of mercury are circulated through the turbine per minute, there is a possibility of getting $4{,}200 \div 42.4 = 94.5$ H.P. if there were no friction or other losses in the turbine. The exhaust mercury would produce 8.42 lbs. saturated steam at 400°F, and under similar conditions to the above this steam would make available $3{,}210 \div 42.4 = 76$ H.P. The total for the combination is thus 170 H.P., the range of temperatures from 810°F to 80°F, and the maximum pressure 247 pds. The upper temperature is not possible with saturated steam alone. The possible efficiency of such a machine using Carnot's cycle is 62.4%, and neglecting heat transfer losses, the Rankine cycle efficiency would be 13,910 B.T.U., the heat required from the oil used as fuel, divided into $4{,}200 + 3{,}210 = 7{,}410$ B.T.U. the work recovered, which gives an efficiency of 53%.

Saturated vapour either of mercury or water cannot be used in turbines because of the destructive action of the moisture, but the above method will illustrate the mercury process, and tables are not accessible for dealing with superheated mercury vapour.

Space prevents a discussion of powdered coal, air pre-heaters, etc., but we seem to be entering a great field in steam power generation and no one can tell to what extent it may go.

THE NEW AERODYNAMICS LABORATORY OF THE UNIVERSITY OF TORONTO

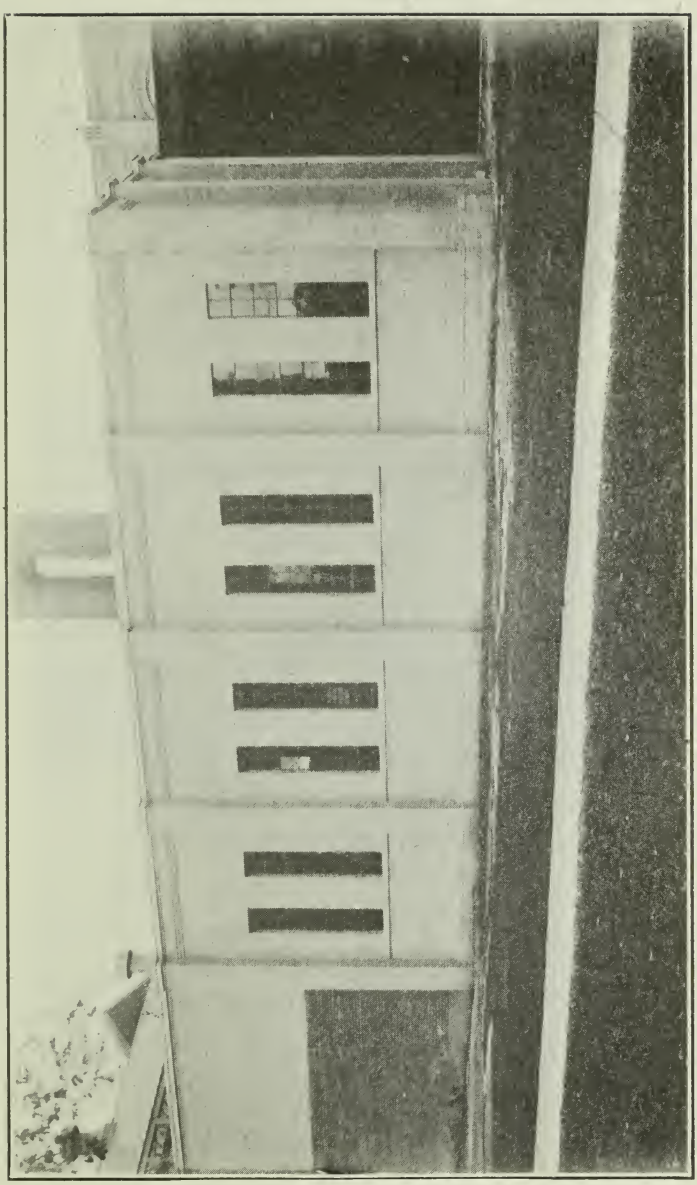
J. H. Parkin, M.E., F.R. Ae. S.

During the Great War, Toronto became the centre of aeronautical activities in Canada. Aeroplanes were built here in huge numbers, the production of aircraft engines was commenced, while the University became temporarily a School of Aviation, where cadets were taught the rudiments of flying, to be afterwards given flying instruction in one of the several aerodromes located in the immediate vicinity of the city. These facts, together with the evident future possibilities of aviation in Canada, led to the preparation of a report by the writer in February, 1917, advocating the establishment of a National Aerodynamics Laboratory at the University of Toronto. Later, after gathering data at laboratories and flying fields in the United States and Canada, a further report was presented to the Board of Governors, as a result of which a special grant was voted by the Board in June, 1917, for the installation of a wind channel complete with the necessary equipment.

The channel was fabricated in Toronto, to modified National Physical Laboratory designs, and a balance secured out of a special batch being made for the British Government in England. As a separate building could not be provided at the time, the channel was erected in the Lower Hydraulic Laboratory of the Mechanical Building. After the initial tuning up and calibration, much time was consumed in preliminary studies to overcome the disturbing influence on the channel operation of the other apparatus in the building. These difficulties were finally successfully overcome by the development of a new and very satisfactory form of channel intake.

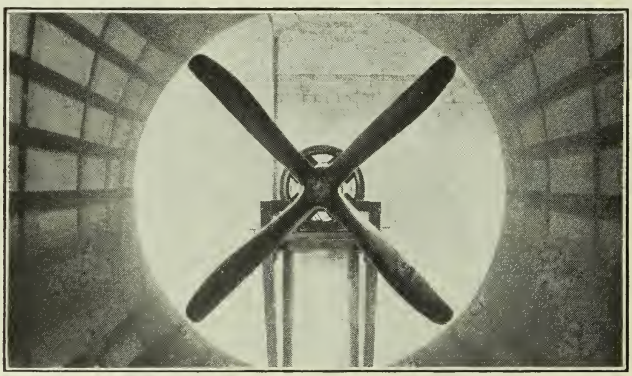
Between 1919 and 1923, much valuable research work was carried out, principally in the summers, as the noise rendered operation during the term impossible. Last year additions to the equipment of the hydraulic laboratory rendered the continuance of the channel impossible in this building, and after some weeks of high pressure work, in some cases as much as twelve hours per day, the channel was dismantled in August, 1923.

The Air Board of Canada and later the Department of National Defence, realizing the national character of the Toronto Aerodynamics Laboratory, the only one in Canada, granted the University of Toronto, through the Honorary Advisory Council for Industrial and Scientific Research, five thousand dollars toward the erection of suitable building to house the wind channel in return for such facilities as had heretofore been available to the Department. The offer was accepted by the University, and the building erected during the summer of 1923, the additional cost over and above that of the grant being borne by the University. The



building is of buff brick 60′0″ x 23′-3″ x 20′-0″ high inside, and forms a wing of the Mechanical Building.

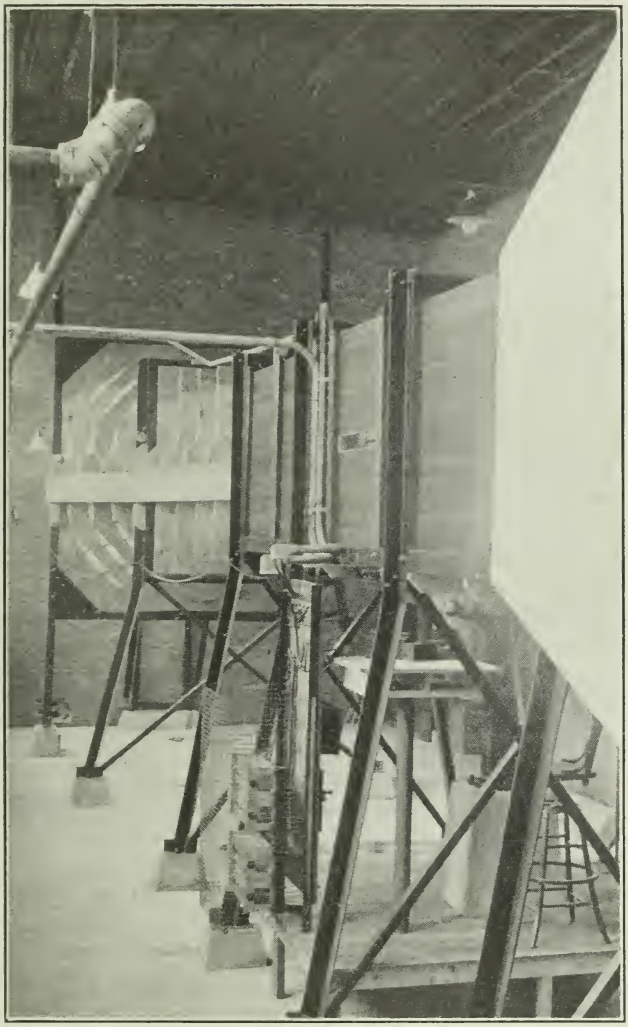
The building was formally opened on Feb. 8th, 1924, by Major-General J. H. McBrien, Chief of Staff, Department of National Defence, and the channel formally started by Brig-General C. H. Mitchell, Dean of the Faculty of Applied Science and Engineering, in the presence of a gathering including Sir Robert Falconer, Sir Edmund Walker, Dr. H. J. Cody, Group Captain M. C. Christie, Air Attache British Embassy, Washington, Dr. David W. Taylor, Rear Admiral, U.S.N., representing the American National Advisory Committee for Aeronautics, Wing-Commander E. W. Stedman, Technical Director Royal Canadian Air Force, Dr. A. S. Eve, Chairman Associate Air Research Committee of Canada, and Mr. C. Roy Keys, Vice-President Curtiss Aeroplane & Motor Corporation.



The 4-Blade 9′ 6″ dia. Propeller

The wind channel in an aerodynamic laboratory performs the same function with respect to aircraft and aeronautics as the model experimental basin performs with respect to vessels and naval architecture, or the hydraulic testing flume performs with respect to turbines and hydraulic engineering. Its use is based on the principle of relative motion. Instead of experimenting in actual free flight with full scale machines, an exact replica or model of the machine or some element of the machine to be studied, is mounted on a sensitive balance in the wind channel, and a smooth steady current of air drawn past the model (instead of moving the model through still air) and the forces on the latter measured. In this way the performance of the full scale machine in free flight can be accurately predicted at much less cost, in less time and without the inconvenience, difficulties and hazards of free flight testing, while at the same time the exact conditions can be readily duplicated.

The wind channel in the new Aerodynamic Laboratory is of the Royal Establishment type. The channel is some 50 ft. long over all, the



View of Channel from Intake End

tube proper being 4 ft. square in section, and 24 ft. long. At the entrance end the tube is fitted with an intake and honeycomb to properly guide the air entering the channel. At the exit end a large carefully designed trumpet shaped outlet cone of heavy fabric, expands from the

4 ft. square section to a 9′-10″ dia. circular section in some 20 ft. A four-bladed 9′-6″ low pitch propeller located at the outlet end of this cone and direct driven by a 20 H.P. shunt wound electric motor, induces the air current in the channel. The speed of the motor is manually controlled and covers a wide range, enabling speeds from 9 or 10 to between 60 and 70 miles per hour tobesecured. This latter speed represents a gain of 100% in efficiency over the previous channel, which was of the National Physical Laboratory type.

The balance is of the English or National Physical Laborotory type, which permits the measurement of forces in three planes and moments about three axes mutually at right angles. It sensitively is such that it will tilt for a force of 0.0001 lb. on the model. A number of improvements have been made in the balance at Toronto, with a view to increasing its usefulness and convenience of manipulation.

Aircraft models with a maximum span of 24 to 30″ can be accommodated. The models are thus to a very small scale and hence must be made with great accuracy. Ordinarily the models are within one or two thousandths of the required dimensions. Models are made of metal (steel, brass or aluminum) wood, and in some cases of wax.

Since the forces on the model vary as the squares of air speed, great precision is necessary in measuring the speed of the air current. A Chattock micromanometer is used for this purpose in conjunction with a side plate in the wall of the channel. The micromanometer is sensitive to the ten thousandth of an inch of water, and the air speed may be measured within ½%.

Many useful researches have been carried out in the channel at Toronto. An extensive investigation of the best form of wing tip for aeroplanes was made, leading to very definite results. An investigation was undertaken at the request of the Air Board of the effect on the characteristics of tapering thick high lift wings such as are used on commercial aeroplanes. A most comprehensive study of the downwash in the rear of such wings has been completed. New commercial wing sections of god characteristics were developed last year. Bulletins giving the results of these investigations have been published and have attracted favorable notice in Great Britain and the United States.

In addition to purely aeronautical work, many other problems in connection with the flow of air have been attacked. Thus the Meteorological Service cup anemometers were investigated, and, as a result, a new and improved three-cup type has been developed, having superior qualities, which has been adopted in the Canadian Service. Tests of roof ventilators and chimneys may be made and anemometers rated.

Not the least important part of the work is the training of skilled research men. Good research men are scarce and difficult to secure. A man to be successful in research must possess the proper temperament and ability, a thorough grounding in the fundamental sciences and training and experience in experimental work. Aerodynamic research work affords particularly good training because of the nature of the problems encountered and the precision required.

THE BUILDING PROFESSIONS AND FIRE PREVENTION

By J. E. Ritchie, B.A.Sc. 13, Fire Prevention Engineer,

Office of The Ontario Fire Marshal.

We Canadians are fond of referring ,with perhaps pardonable pride, to the many vast resources of wealth with which nature has endowed us. We are also prone to feel an exalted satisfaction in our own accomplishments in developing these resources and transforming them by our hand and mind into large and beautiful towns and cities, attractive and productive farm lands, and the products of our varied industries. We make so little effort to preserve the fruits of our labor that it must appear to a thoughtful observer that our pride is more or less superficial. When a man has spent the greater part of a lifetime in building himself a home he exxperiences considerable proud satisfaction in its completion. A sudden destruction of this home would be a distressing blow to its builder. We, as a nation, are developing and building up a country which will be a home to us and to prosperity. If we take a proper interest in it we should certainly be expected to make an earnest effort to preserve our resources, both natural and developed. Year after year a tremendous loss is suffered through the destruction of property by fire, and yet we raise scarcely a murmer.

Ontario's Fire Loss

In the year 1923 Ontario suffered a loss of $18,344,587—the result of 10,941 fires. In 74 of these fires casualties occurred, comprising 70 killed and 78 injured. If this Province suffered so great a loss from some other single source we can rest assurred that strenuous efforts would be put forth to prevent it. If some plague threatened our fisheries, the trees of our forests, the fruits of our orchards, the grain of our fields or the cattle of our farms, the calamity would be broadcasted in all directions and no effort would be spared to stay the pestilence; and yet, although it seems incredible, this great waste as a result of fire plague, receives but passing attention in spite of the fact that 80% of it is easily preventable. It is difficult to make satisfactory progress until those controlling the destinies of our country are brought to a realization of what a loss this really is to our National Treasury.

Cause of Fire Waste

While we undoubtedly suffer fire loss on account of inadequacies of fire extinguishing equipment, this enormous waste of the sinews of our country can be attributed almost wholly to the following three outstanding causes:—

(1) Indifference and carelessness.

(2) Ignorance of the dangers attendant upon many conditions which are fire breeders.

(3) The lack of fire resistive construction.

The best way to prevent loss by fire is to build safe. Neither fire departments nor insurance companies insure against fire or conflagration. The former attempt to extinguish them and the latter partially collect and distribute their cost. Careful customs and habits and careful building will prevent fire or conflagration.

Responsibility of Architects and Engineers

The work of fire prevention and fire protection is not a one man job. It is the duty of every citizen in every walk of life. The combined efforts of architects, engineers and builders in this direction would do much to solve the vital problem. Their position with regard to fire prevention and fire protection is unique, as upon them will largely depend the standard of the buiding construction which is to represent the homes, shops and factories of our rapidy growing nation. Indifference is not confined by any means to the property owners and their representatives, but it is too common among our builders and even the architects of our towns and cities.

The science of fire preventive construction has made wonderful strides in the last twenty years. Fire resistive construction and fire protective devices are no longer an experiment or an extravagance available only to wealthy organizations. Millions of dollars are being invested each year in buildings, both in cities and in the open country, which are not only dangerous to life and liable to cause great financial loss, but which represent an actual waste of the owner's money in combined original cost and up-keep. Common "joisted construction" stores, shops and industrial buildings are still being erected in such large numbers as in many cases to be little less than an economic crime.

It is often said than an engineer's work remains as a monument to him after he is gone. His professional faults and virtues are not forgotten but remain exposed to the critical eye of posterity. If we build today, and in the future so as to resist fire, the credit will reflect upon the building professions, and their work may be truly said to be "a thing of beauty and a joy forever." But, if we continue to build structures which rapidly fall prey to the flames, leaving loss, ruin, death and destruction as a monument to our memory, the beauty will be marred and the joy short-lived, and the professions cannot hope to win the appreciation and recognition which they should enjoy in the mind of the public.

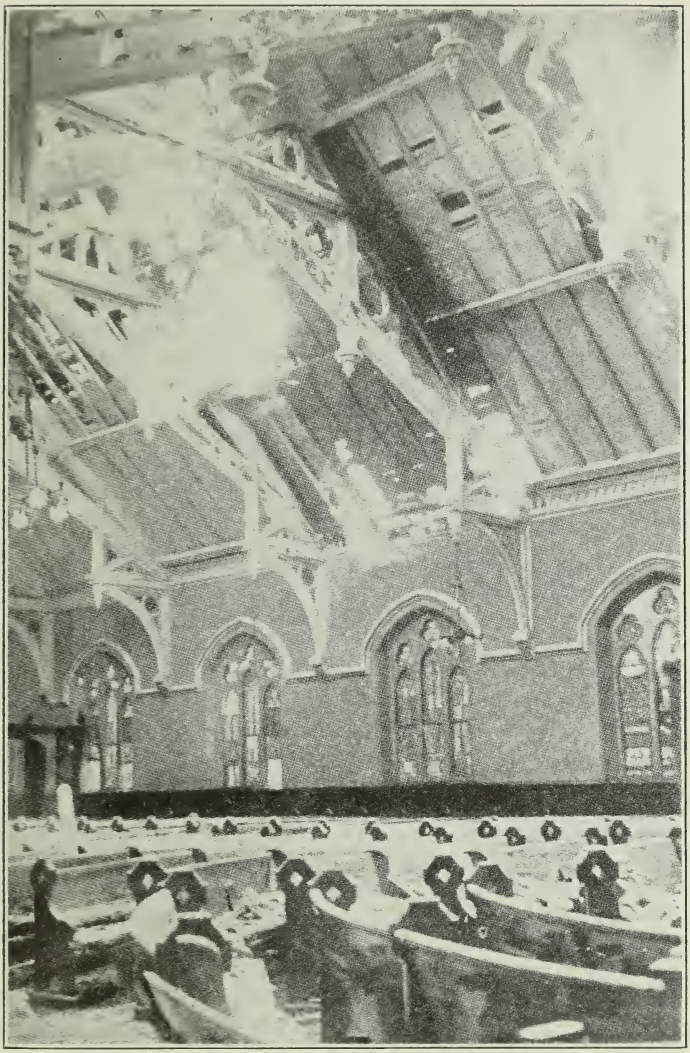
Localizing Fires

All fires are small in their beginning and if they can be localized the loss of life and property will be minimized. There is only one way in which this localization can be effected, and that is through proper building methods, including in particular, adequate vertical and horizontal subdivisions. Fire spreads primarily in four ways as follows:—

(1) From floor to floor in the same building.
(2) Horizontally in the same building.
(3) From building to building adjoining.
(4) From building to building not adjoining.

Vertical Spread in the same Building. Fire travels from floor to floor in the following manners:—

(a) Through unprotected floor openings such as those for elevators,



Church Burned from Spark Settling on Inflammable Roof

stairs, dumb-waiters, belt ways, chutes and pipes.

(b) By burning through floors.

(c) By burning through inadequate protection provided for vertical openings.

(d) By travelling vertically in partitions or behind lath and plastered walls where fire stops are not provided.

(e) Through external windows or other wall openings.

The most natural way for a fire to spread is in a vertical direction, either up or down, as a result of the flames and heat being carried upward by the created draft or of sparks and burning embers falling down through unprotected openings.

Horizontal Spread in the Same Building. Fire spreads horizontally in the same building in the folowing ways:—

(a) Over large areas containing inflammable materials and not subdivided by fire-walls.

(b) Through unprotected openings in walls.

(c) Through inadequate protection provided for openings in walls.

(d) By travelling in spaces between ceiled joists where fire-stops are not provided.

Vertical protection alone is not sufficient for, if large areas on the same floor become involved in fire, much unnecessary loss will be entailed and the heat may become so intense as to break down what would otherwise be adequate vertical protection.

Spread from Building to Building Adjoining. Fire will spread from a building to adjoining buildings on account of:—

(a) Unprotected wall openings.

(b) Failure of fire doors or other protective coverings for wall openings.

(c) Lack of parapets.

(d) Flashing over or around parapets and igniting combustible walls, roofs, roof coverings or monitors or pent houses.

(e) Passing from windows on one side to those on the opposite side of a division wall.

(f) Diagonal exposure of openings in walls at right angles to each other.

(g) Heat passing through walls, especially at points where timbers are set into them.

(h) Failure of walls as a result of the falling of structural timbers embedded in them, or as the result of explosions.

Too often we find that a premises is subject to practically all the fire hazards of an adjoining premises because the possibility of fire spreading from one to the other has never been realized. Divisions or party walls which are absolutely fireproof, supplemented with adequate parapets, are a decided factor in preventing the spread of fire to serious proportions.

From Building to Building not Adjoining. Fire spreads from a building to another detached building through:—

(a) Combustible exterior walls.

(b) Unprotected wall openings.
(c) Overhanging roofs.
(d) Combustible cornices.
(e) Combustible monitors and pent houses.
(f) Combustible additions, passages or other structures.
(g) Permanent or temporary openings through which sparks or brands can pass.
(h) Combustible roofs.

The spread of fire from the foregoing causes is a matter of grave concern to every fire department, for in this way the stage is set for a conflagration. Instead of a single fire unit several fires are set up making it difficult for the firemen to successfully cope with the situation.

Remedies

The remedy in each of the above cases is self-evident to architects, engineers and builders who have kept apace with the improvements and appliances of modern building. Fire prevention means not only the use of fire-resisting materials but also fire resistive design and methods of construction. In a great many cases buildings which are veritable fire traps and which would in a short time become totally involved in a fire, could be made comporatively safe with very little expenditure. Proper stops in walls and partitions and between joists, a fire door here or a protected floor opening there, would in all likelihood confine the fire to the section where it originated until it could be successfully dealt with by the fire department. While it is impossible to deal in detail with all the various means of preventing the spread of fire through proper construction, I will refer to a few features which assert themselves rather prominently.

Fire-Stopping

The importance of fire-stopping in all buildings and particularly in the case of frame consruction, for the purpose of retarding the progress of fire, is an established fact. The greater portion of fires are of interior origin and therefore some method of fire-stopping is advisable and necessary.

The principle to be applied in fire-stopping in frame construction is that of closing all vertical openings between studs and all horizontal openings between joists for the purpose of preventing the rapid circulation of fire by draft. It has been the experience of fire chiefs that the spread of fire in frame buildings is due largely to the lack of proper fire-stopping.

Fire-stopping between studs, preferably with non-combustible material, will tend to confine a fire to a cellar or basement and prevent its rapid spread to storeys above. It is equally effective in case of a fire whose origin is on the upper floors as it will prevent sparks from dropping down through openings and causing fire below.

In buildings of ordinary construction there should be fire-stopping at each floor level in all walls, partitions, furrings and spaces between joists where they rest on division walls and parapets, so as to completely cut off communication by fire through concealed spaces by preventing both vertical and horizontal drafts. When sliding doors are pocketed in partitions care should be exercised to see that such pockets be completely fire-stopped at top and bottom. The space between stair carriages should

be fire-stopped at least once in the middle portion of each flight and should be fire-stopped by a header at both top and bottom.

Chimneys and Fireplaces

Last year 522 fires occurred in the Province as a result of defective chimneys entailing a fire loss of $432,308. During the same period faulty heating equipment and faulty installation of heating equipment caused 1,557 fires in the Province with a loss of $1,367,827. From the foregoing figures it is evident that drastic improvements are necessary in connection with provisions made for the heating of our homes, factories and warehouses. The losses occasioned from these causes are almost entirely preventable, and should therefore receive our whole-hearted attention.

Chimneys built on wooden brackets should not be tolerated. Through shrinkage, settlement and other causes cracks are apt to develop and a fire result. Chimneys built of a single row of bricks without any tile lining, are not reliable. Through the action of heat, smoke and gases of combustion the mortar gradually deteriorates and crumbles until finally the bricks become loose and openings result through which sparks may pass and cause fire in blind attics or other concealed places. We often see chimneys in a state of collapse above the roof line. The same conditions are likely to exist, although possibly in a lesser degree below the roof line, and it is this fact that accounts for so many fires from defective chimneys.

Chimneys when not built in the outer walls of masonry buildings should be placed on a solid foundation of rubble stone or concrete below the frost line. A well constructed chimney should have a lining of at least ¾ inch fire tile placed in the entire flue from a point below the lowest thimble hole to the very top of the chimney and laid in cement mortar. Chimneys should never support any part of the structure such as joists, beams or girders. This practice frequently causes cracks due to uneven settlement between the different parts of the building, and woodwork very often becomes ignited from resting on or coming in contact with chimney walls. Joists should be framed out around chimneys and kept at least 2 inches from masonry and for open fireplaces should have a clearance of at least 20 inches. Fireplaces and chimney breasts should have trimmer arches or other approved fire resistive construction supporting the hearths.

Fire Walls and Party Walls

In many cases the significance of a fire or party wall is largely lost sight of. What would otherwise serve as a fire wall is too often found with unprotected openings which destroy its effectiveness as a fire-stop. Unless a fire wall is continued through the roof so as to form a proper parapet it cannot be considered as an effective barrier. Occupants of buildings often feel a sense of security because they are separated from the adjacent occupants by solid partitions. Their sense of security is frequently very rapidly dispelled through the spread of fire in a common attic, continuous over the various sections, as is often the case in terraces of dwellings.

Wood Shingles

The wood shingle is one of the greatest enemies of fire preventists. It can be safely stated that practically every conflagration has reached its unduly large proportions as a result of this fire spreader. In the case of a moderately intense fire, burning brands of wooden shingles are carried for considerable distance, often in the absence of any wind apart from the draft created by the fire, and falling on other shingle roofs cause a series of fresh fires, each of which in turn becomes another potential hazard. In almost 100 cities of the United States the use of wooden shingles is prohibited within their corporate limits. In addition, restrictions are enforced by which the percentage of repairs permitted to existing wooden roofs is limited, and in many cases the date for the entire removal of existing combustible roofs is fixed, generally about ten or twelve years from the date of the passing of the ordinance.

The following is an extract from a report on the conflagration which destroyed a large portion of the City of Berkeley in California last fall:—

> "Of the 584 buildings totally destroyed, 540, or 92-3/8%, had roof coverings of wooden shingles. Of all the factors entering into the rapid spread of the conflagration, not excluding the high wind and the weak water system, this was of greatest weight. Had roofs been covered with fire-resistive material the conflagration would never have attained serious proportions. Motion pictures taken during the fire show exactly how wooden shingles contributed to its spread. Under the influence of the high wind, burning shingles were carried from roofs of buildings already well involved by the fire and deposited on other shingle roofs which in turn quickly burst into flames. Shingles are just light enough to be carried some distance by even a moderate wind, and just heavy enough to remain on fire for some time. Again and again shingle roofs were noted bursting into flames two or three blocks in advance of the main front of the fire. In at least one instance, the roof of a dwelling half a mile in advance of the main front of the fire was ignited by flying brands, and this fire was soon communicated to adjoining buildings.

Automatic Sprinklers

The value of automatic sprinklers does not appear to be fully appreciated by a great many citizens who have large interests at stake. It is, in fact, no longer regarded as a matter of experiment but as a certain remedy and its effectiveness is largely due to the fact that it depends on no human agency in its operation and is on the job 24 hours a day. The installation of a proper system of automatic sprinklers is recognized by Underwriters in the form of a reduction in insurance premiums of from 40 to 90%, depending on concentration of values and special hazards. This should be sufficient proof to the skeptical that the sprinklers are a real protection. In many cases their introduction would ultimately be of economic advantage to the owner, and architects and engineers can do a great deal to encourage their installation.

Exit Facilities

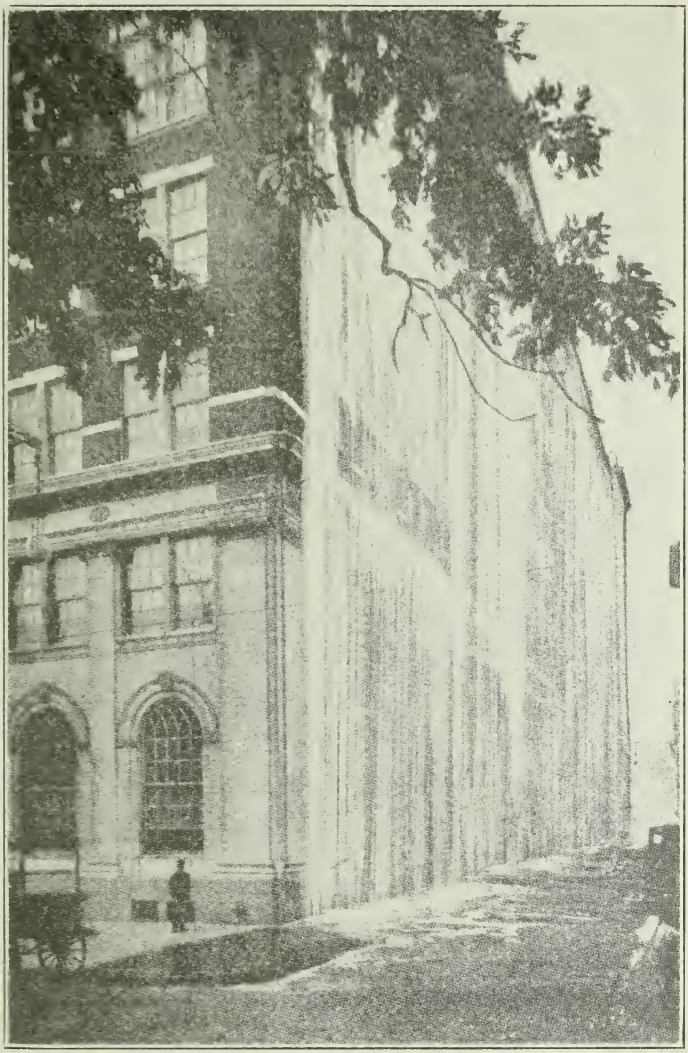
Fire-escapes perhaps receive less intelligent consideration than any other phase of work or device intended to provide safety to property and life. Iron ladder-like stairways anchored to the side of buildings and passing unprotected windows at every floor are really about as deceptive a trap as could be devised. A hot iron fire-escape with tongues of flames issuing onto it from windows cannot be considered a wise means of assisting a panic stricken crowd in making an escape from a burning building. Even if such a structure is free from obstructions such as milk bottles, ice boxes, etc., it may easily become hopelessly jammed by a rush from several floors or by timid inmates who become frightened at dizzy heights.

A writer once described the iron fire-escape in the following manner:—

> "The ordinary step fire-escapes are iron contrivances fastened on the outside of buildings. They are put up under contract and may often be found without the use of a guide book to the building. They are semaphores to show that human lives inside are in danger. A cautious person should never go inside a building supplied with these fire-escapes. They are not put up by accident as many suppose but for definite reasons and are used for four purposes:—
>
> (1) They releive the monotony of a building by lending a touch of quaintness to the architectural scheme.
>
> (2) They may be used by limited number of athletes who are capable of worming themselves out onto them for reviewing parades and processions.
>
> (3) They are placed at such a great height from the sidewalk that they are always a perplexing problem to burglars who desire to scale them.
>
> (4) They are a great technicality evader; for with one painted on his factories a factory owner can go home and sleep the sleep of the just knowing that though a fire break out he cannot be held responsible."

While the foregoing may be an exaggeration yet a careful observer and keen student must realize that many unnecessary hazards are associated with the fire-escapes referred to, and it is claimed that more people are killed and crippled annually on such escapes than are burned in fires.

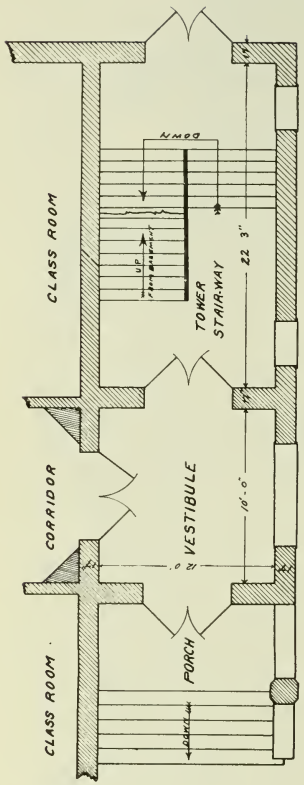
Double Tower Stairways. An ideal means of exit is by a fireproof stair tower which has no direct communication with the building but which is reached by way of a fireproof vestibule separated from the interior of the building and the stairs by fire doors which open with exit traffic. The intermediate vestibule, preferably well vented to outside air, serves to prevent the stairway from becoming filled with smoke and causing panic even when no immediate fire danger is threatening. The construction of double tower stairways (each tower consisting of two divisions —the vestibule and the stairs proper) is the only means of eliminating inside stairways and openings between floors so as to make each storey an independent fire unit. They provide almost complete safety against



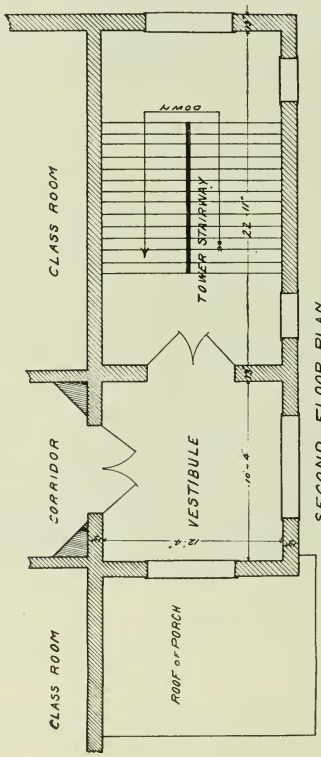
This Sprinkler Water Curtain Makes an Efficient Barrier Against Exposure Fire

rapidly spreading fire in all buildings not fireproof and against smoke panic in even fireproof buildings.

Double tower stairways are adaptable to buildings of any construction and any occupancy. Their use in schools is of great advantage because they not only relieve the parents and teachers of anxiety regarding



FIRST FLOOR PLAN



SECOND FLOOR PLAN

DIAGRAM SHOWING PLAN OF DOUBLE TOWER STAIRWAY
FOR TWO STOREY SCHOOL BUILDING
Scale-1" = 4 ft

the safety of the children in case of fire but also cut off the noise and confusion incident to dismissal of classes from one part of the building while other classes are still in session. In some of the states of United States, including North Carolina, this means of exit has been adopted in many schools and found to be highly satisfactory.

The adoption of double tower stairways facilitates a convenient layout of the interior of the building without any loss of floor space. The reduction made possiblee in the dimensions of the building proper through corridors of reduced width and the elimination of open stairways will compensate to a large extent for the cost of construction of the towers.

Smoke Hazard. The danger from smoke panic has not been sufficiently recognized or guarded against in the construction of schools. Reliable statistics indicate that over 80% of the casualities in school fires are not caused by burnings but by smoke and panic, the subjects being not even touched by fire. When an urgency arises we should at least allow the children to make their escape through fireproof, smoke-proof towers which they are in the habit of using every day, instead of through smoke-filled corridors and open stairways or on inadequate stairways fastened on the outside of buildings where an accident is liable to happen to timid panic stricken children.

Considerations which Determine Necessary Exit Facilities. Even this fireproof stair tower may at times prove inadequate under panic conditions. The best additional safeguard is a fire-wall running through every large area so as to divide each floor into two separate fire sections, with firedoors for means of horizontal communication.

While the number of people occupied in a building should in some degree influence the accommodation for exit, yet in most cases the material occupancy is of greater importance. In case of fire, time is an important factor in making an escape. Occupancies are the chief source of hazards and they also determine the length of time during which fire-escapes can be used after the outbreak of fire. The probable cause of fire and its liability to develop should certainly be an important factor in making provision for a hasty exit. Let me illustrate this point by an extreme case. It is apparent that the stairways adequate for a cold storage plant would not be sufficient for an assembly hall or for a factory which housed large quantities of very inflammable material even though this building may be fire resistive to the highest degree. It must be remembered that the greater number of those who lose their lives thrcugh fire are first overcome, and in many cases killed, by the dense smoke and other products of combustion.

The tendency appears to be to insist upon fireproof stairways in fireproof buildings more than in those buildings which are not fireproof. The reverse should be the case as it is quite evident that a fire will develop more readily in the building of the latter type and so cut off the occupants from escape in a much shorter time. The more hazardous the construction of a building the more reason there is for providing readily accessible adequate means of safe exit.

THE PREVENTION OF FIRE BY GOOD HOUSEKEEPING*

By Percival H. Take, 4th Year. Dept. 3.

Canada is a country of vast natural resources. Her great forests, mineral wealth, great stretches of fertile lands and her many rivers waiting to be harnessed for the use of her sons are a heritage of which we can be justly proud. Is it consistent then that Canadians who have so ably proved their nationality in war and in peace should dissipate their inheritance through ignorance and carelessness—the essence of poor housekeeping—at the altar of the demon Fire?

The Province of Ontario alone during the year 1922 suffered losses by fire aggregating 98 precious lives and $22,018,000 in property destroyed. It is true that 1922 was the year of the great Northern Conflagration but the fire losses exclusive of this totalled some $15,648,000. Each year the estimated fire loss of the Province tends to show considerable increase over and above that of the previous year. Consider for a moment just what this means.

The individual fire losses were to a great extent covered by insurance but the loss was none the less carried by the individual himself on a credit or time system of payment. The fire Insurance companies base their premiums on the average fire loss for any particular class of risk plus a substantial margin. A higher percentage of fire claims therefore mean higher protection taxes over the whole neighborhood.

The economic effect of destruction of property by fire is very far-reaching. In the first place it is a direct loss to the country, for property destroyed by fire can never be replaced. The burning of a factory may bring untold misery and hardship to an entire city, more especially upon those people who are dependent upon the running of the factory for their means of earning a livelihood. Destruction of warehouses, stores and elevators has a general effect of raising the price of all commodities. Drawing of men from the available labor supply for the purpose of rebuilding tends to increase the cost of labor. So that look at it whichever way you will, in the end, all pay.

Consider the four leading classes of fire risks namely, dwellings, stores, barns and factories. According to the extract from the Ontario Fire Marshal's report of 1922, shown below, dwellings come first in point of number, each one of which is a potential conflagration.

Class of Property	Number	Loss.
Barns	1000	$2,221,696
Dwellings	6209	2,580,258
Stores	1776	3,864,635
Factories	462	3,602,263

Statistics show that a great majority of these outbreaks are attributable in the main to carelessness and neglect, and are thus in the strictly preventable class. The chief fire losses occur however in the destruction

*Prize Fire Prevention Essay in Division of Mechanical and Electrical Engineering.

of stores, factories and barns. In these cases also the fire demon claims his toll through his chief agents, Carelessness and Neglect.

Canada has the greatest per capita fire loss in the world. What then is the conclusion? Can we afford to go on burning up our natural resources at a rate which is now some $15,000,000 a year for the Province of Ontario alone, a loss which is increasing at the rate of about 47 per cent every five years? Can we afford to pay the price as a penalty for allowing the accumulation of rubbish and for neglecting to take ordinary precautions?

Analysis of the causes of fires shows that in many cases it is impossible to arrive at a sound conclusion as to the cause of many fires. The loss due to fires started by electricity exclusive of lightning is such as to occasion grave concern.

Electricity is not to be played with. Its peculiar prank is to start fires when and where they can not be easily detected until the fire has gained considerable headway. Even then in a great many cases it is difficult to get at the fire to quench it. Fires due to electricity are started in many ways, from the circuit breaker and transformer explosions in electric stations to the ignition of paper shades on electric globes in the home. Electric light, is, however, much safer than any other form of artificial light when it is installed in strict conformity with the rules and regulations of the H.E.P.C.

This is not all that's necessary for safety. The user should know how to control the wonderful power which he has at his disposal. It is very easy to overload circuits and to bridge fuses when they "blow" but it is a different matter trying to control the fire which may be the result.

It then behooves the good housekeeper to see that conduits and the installation generally meet the requirements of the H.E.P.C. Circuits must not be overloaded by attaching heaters, washing machines, and small motors indiscriminately to the lighting circuit. If fuses are in the habit of "blowing" it is a sign that something is wrong and an inspector should be called; fuses should never be bridged. When using the electric iron it should always be put on its stand or the current switched off before the user leaves the room. If these simple precautions were followed a great deal of distress, suffering and loss would be avoided.

With regard to lightning we now know this to be a kind of electricity which manifests itself by discharging to earth when conditions are favorable. As electricity it follows the law of choosing the path of least resistance. Air is a very poor conductor and metals are good conductors of electricity. Thus if the roof of a building or other structure be covered with metallic conductors and these conductors be led away to moist earth the lightning if discharged at or near the building will be conducted to the ground without causing trouble; providing suitable air terminals have been installed.

Unfortunately lightning rods have been installed in the past by persons who were only interested in the sale of such rods. In many instances lightning rods have been installed without the precaution of making sure that there was a good earth connection. Rods installed in this way

do not comply with the Regulations in force under the Lightning Rod Act of Ontario.

With the great power let loose with the discharge of lightning it is not necessary that the lightning actually strike the building in order to cause a fire. Take for instance a barn with a long hay rod. There may be a sufficiently high voltage induced in the hay rod to start a fire even though the actual discharge takes place several hundred feet away. It is then absolutely essential that the lightning rods themselves as well as hay rods, windmill guy rods and all manner of mettallic pipe lines be grounded effectively. Under the Lightning Rod Act effected January 2nd. 1922 the public are now safeguarded from faulty installation of lightning rods. This does not apply to those whose buildings were rodded prior to that date. The appointing of inspectors and education of the public along these lines will go a long way towards removing the great loss which the country sustains each year through fires caused by lightning. The efficacy of lightning rods protection is very strikingly shown in the Ontario Fire Marshal's Report for 1922, in that of 1012 buildings destroyed by fires due to lightning only eight were rodded.

The next largest contributor to our annual "ash heap" is spontaneous combustion,—fire which starts of itself. This phenomenon is readily seen when heaps of waste, rags, wool and cotton soaked with oil are left lying around. The chemical action generates heat, and this heat increases the rate of chemical action thus evolving a still higher temperature. The vicious circle thus constituted continues until the temperature of combustion is reached at which the mass bursts into flame of itself. The moral to be gleaned is simply that of not allowing this rubbish to collect in or around buildings. Piles of soft coal are also subject to this action and should never be piled more than eight feet in depth; nor should it be piled against wooden partitions or steam and hot water pipes. Many barn fires are caused by the storing of hay before it is properly dried. It is hard to understand why hay is stored away in this condition since animals do not relish mildewed or spoiled hay. The hay would be better left in the fields even through a shower of rain than to run the double risk of storing while wet. The liberal sprinkling of Salt over the hay as it is being stored away is a good preventative of spontaneous combustion.

It is most significent that the greatest fire losses are attributable to the two causes just described. The nature of electricity and spontaneous combustion is less understood by the general public than those fire starters whose action can be seen. It is to ignorance that we must lay many of our charges of fire waste and we must combat it by education.

Fire Prevention is mostly a question of common sense combined with the element, care. Smokers should be very careful as to when and where they smoke and as to what they do with their burnt matches, cigarette and cigar butts. All heating apparatus flues and chimneys must be kept in good repair and surrounding woodwork carefully protected from any danger of fire. Oils, gases and vapours should be treated with the utmost respect to prevent untimely ignition.

Home, factory or warehouse all should be kept free from scattered or piled rubbish, as rubbish makes the best fuel for fire. In factories where dust is a necessary product of the process, some method of disposing of the dust to keep it from circulating in the atmosphere should be used. Most organic dusts besides being unhealthy, are, when mixed with air in the right proportions, extremely explosive.

Such are the essentials of Fire Prevention by good housekeeping.

FIRE PREVENTION IN THE HOME*

By John W. McFarlane, 1st. Year, Dept. 6.

Common sense is the antidote for the fire menace. A reasonable amount of this unfortunately somewhat rare commodity is worth more than an insurance policy. The man who deliberately refuses to take ordinary precautions is almost as guilty as the individual who leaves a candle burning in a basin of gasoline. More care exercised will naturally reduce fire losses.The company does not pay these losses—you do. You pay for your own and your neighboud's carelessness. Every fire is a destruction of wealth and a loss to the whole community.

The kitchen, being the workshop of the home is the most likely source of fire. There is little danger from an electric range, but as the majority of stoves in use are gas or coal, a few pointers are in place. Never have a loose, hanging curtain near the stove. If the kitchen is so designed so as to have a window close to the stove, either remove the curtain altogether, thus letting in more light, or secure it at the bottom, which does not mar the artistic appearance of the room.

Hang asbestos pads, which are designed for handliing hot articles, conveniently near; a lose dish towel is apt to come in contact with the flame. In starting a wood fire with coal oil, an egg-cupful will cause flames to flare out in all directions. The effects of pouring from a can on a fire are well known. A match safe, with a receptacle for dead ones should be provided. A covered safe is necessary for live matches. In the processes of cooking, frying, especially deep fat frying, is apt to cause a blaze.

Ashes from the furnace or stove are a source of danger. They should not be put in a wooden box as this is contrary to safe practice and Insurance Regulations.

It is best to use galvanized cans altogether. Where a range is used, it is advisable to have the wood-box at some distance from it. Every stove should have some sheet metal betwwen it and the wall and floor. It is well to remember that any leaks in the taps or like fittings on a gas range should be attended to by a plumber. Explosions caused by almost imperceptible leaks in lighting a gas oven are not uncommon.

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*Prize Essay in Division of Chemical Engineering.

A grate fire is not a dangerous thing, but a few precautions should be observed. Cushions should not be left near a fire place. A wire guard is a necessity and should always be used. If faulty construction is suspected in the hearth, it is well to examine closely.

A careless, if not dangerous construction, is the laying of tiles on woodwork. Cases are on record where fires were started by this defect. After the grate had been burning for three days, a wisp of smoke was noticed to be coming through a crack in the floor on the other side of the room. A board was torn up to ascertain the cause and a flame shot up to the ceiling. Such was the effect of careless workmanship.

Chimneys should be cleaned regularly once a year. The accumulation of soot becomes a menace, and all that is needed to touch it off is a large, hot fire in the grate, furnace or stove. The result is quite spectacular, and it sometimes becomes necessary to spend part of a night on the roof with a bucket of water. A chimney fire, combined with a shingled roof is a proved fire recipe. The moral is, set a definite time to have the chimney swept, preferably just before the spring cleaning. It is wise to hire a skilful man with proper equipment for this work, as a tyro is liable to dislodge bricks or cause other trouble.

As a garage is usually close by or even under a modern house, a few words on it are not out of place. A cement floor is infinitely less dangerous than wood, so if there is any occasion for renewing it, cement will minimize the fire hazard. A car almost invariably drips oil. A pail of sand should be left handy and contents sprinkled on the floor locates and catches the drip. This may be then swept out. Gasoline and oil tins should be kept tightly corked. The gasoline cans should be painted red. Oily rags and waste should be kept in a closed metal can.

An occasional cellar or garret is a glorified rubbish receptacle. Old furniture, magazines, newspapers,—in short, things which have no reason for being at all, are often stacked in wild confusion. This is a lazy man's practice, and a very dangerous one. Once a fire gets a start in these surroundings, it is very difficult to check it. A pile of old rags is a potent self-starter.

There are many good fire extinguishers on the market. One most suited to the house is the carbon tetrachloride type. Unlike that used in many other extinguishers, the liquid does not harm any fabric in the least. The syringe type is very effective and can be used to advantage at some distance from the fire. It is also quite easy to handle. The large type of carbonate and acid extinguisher is rather cumbersome and difficult to handle. It also damages any material it comes in contact with. A powder is put up in tins that is used in the same manner as bottle extinguishers. Neither of these latter two types of extinguishers are recommended by the Fire Marshall's Office.

Electric wiring is a major cause of fires, but the average householder is at the mercy of the workmen in this regard. Repairs should always be made by a reputable firm. Among the myriads of small causes of fires are some unusual, and apparently harmless things. Dustless mops cause spontaneous combustion. They should be stood, business end up, in a

ventilated place, or kept in a covered metal can. The so-called "French Ivory" used in making of toilet articles, can be a potential tool in the fire demon's hands. It is a composition and very highly inflammable. Spirit lamps should always stand on metal trays, and away from all draperies. Any garments should not be hung near an open fire. A cigarette butt and a waste basket make an ideal combination. Empty the baskets regularly and provide ash-trays wherever tobacco is used.

Matches should be kept out of children's reach and not left loose or in pockets. When a home is left vacant, matches should be left only in closed tin boxxes.

A cleaning fluid, such as is used on suede shoes, may cause trouble if applied with too much vigor. In suburban districts the grass should be burned over carefully in the spring. Burn from the house out, and do it before some hobo does it gratis. It is obvious that there are many causes working in unusual disguises. Generally speaking much trouble and expense can be averted by foresight and action.

DRAFT TUBES FOR HYDRAULIC TURBINES*

By J. M. Dymond, IV Year Dept. 3.

I. The Functions of Draft Tubes

The duties of the draft tube in modern hydro-electric practice are:—

(1) To enable the turbine to be placed at a convenient distance above the tail water without sacrificing any of the available head.

(2) To ensure that the water on leaving the "pressure system" of a plant takes with it as little energyy as possible, the expression "pressure system" being used to define those parts of a plant in which water is out of contact with the atmosphere, i.e. penstock, supply pipe, turbine casing and draft tube.

(3) To perform the two duties mentioned above with a minimum of loss at entrance to, in, and at exit from, the tube itself.

These three functions are set down, and will be discussed, in the order in which they have received attention from designers of power plants, and not necessarily in order of importance.

The first duty has to do solely with convenience in construction and maintenance. It is true that the reaction turbine will operate satisfactorily submerged in the tail water, but until the beginning of the present century, water-wheels were not of sufficient strength and reliabilty to be left uninspected for protracted periods. So, if the wheel was operating below tail water level, the tail race had to be pumped out for any necessary examination or repairs. This meant frequent loss of output, where several units discharged into a common tail race, either through a damaged wheel being left out of service until it was convenient to close down the remainder, or through the immediate closing down of the whole plant.

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* Thesis submitted for Degree of B.A.Sc.

With the very inception of large scale hydro-electric development some thirty years ago, continuity of service was a chief aim with designers. This desire for accessibility, coupled with some structural advantages, no doubt, made it appear worth while in one of the earlier plants at Niagara Falls to sacrifice an appreciable part of the head by having turbines discharge into the air over the common tail race. Before many years, however, these turbines were fitted with "suction," or "draft" tubes, which enabled the wheels to be kept above tail water level, but utilized that part of the head between the runner and the tail water (the "draft head.")

The earlier draft tubes were air-tight cylinders of metal, with the upper end fastened to the bottom of the turbine casing and the lower end reaching below the surface of the tail water. The principle used was merely that of the water barometer. A column of water about 34 feet high, *and at rest*, is balanced by the atmospheric pressure. When the water in the column is in motion downwards, the head represented by the velocity with which it falls must also be balanced by the atmosphere, and the theoretic height of the column which may be maintained in a draft tube must be reduced by this head.[1] Any other losses of head occurring during the water's passage through the draft tube must be deducted from the theoretical 34 feet.[1] A further margin of 3 to 4 feet should be allowed to prevent the breaking of the water column in the draft tube, due to inertia effects of sudden changes of load[2] A still further reduction is necessary, owing to the fact that the water passing through the system is never entirely free of air, and allowance must be made for altitude, local barometric variations, and temperature. The result of all these reductions is that, in practice, the 34 feet theoretical maximum shrinks to a "draft head" of 20 to 25 feet for small diameter tubes and much less for large diameter.[3]

The draft tubes reduces the pressure at the runner outlet from atmospheric pressure, or 34 feet of pressure head (which would be the case if there were no draft tube) by the amount of the "draft head." Or, in terms of gauge pressures, the runner outlet pressure is reduced from zero to minus the draft head.

At the time of the introduction of draft tubes it was not possible always to design one runner of sufficient power for the purpose for which one unit was intended. In such cases several runners were mounted on one shaft. This necessitated a long shaft with considerable dead weight on it, and the question of adequate bearings was a serious one. As generators or other machines driven by the turbines were direct-connected, it was only with draft tubes that horizontal units became possible without a prohibitive sacrifice of head, the driven machine having to be kept well above tail water. Most authors of a few years ago make much of this point in discussing draft tubes, which shows what an advantage it was considered to be able to replace the cumbrous and lofty two—, four,— or six-runner vertical units by the more compact and more easily supported horizontal settings. The popularity the latter enjoyed may be gauged by these statements:—"It is only through the draft tube that

wheels on horizontal shafts are possible.[4]—"It is true that the draft tube brought out the horizontal turbine."[5]—"It is this (the action of the draft tube) that permits a horizontal turbine to be used without any loss of head."[6]—and, "It is the principle of the draught tube that permits horizontal shaft wheels to be utilized.[7]

Turning to the second function of draft tubes, viz., the conversion of energy,—it was early realized that the head represented by the velocity of the water leaving the pressure system was a dead loss, and would have to be minimized to obtain good overall efficiency. As there were definite limits to the size of the turbine, high velocities were unavoidable at the runner-oulet, i.e. at the beginning of the draft tube. So any stepping down of the final velocity in the system had to be done in the draft tube itself. This was done by "flaring" the draft tube, thus gradually increasing its cross-sectional area, and correspondingly decreasing the velocity.

It has been found in practice that the angle of flare should not exceed 7° in a straight conical tube, because, otherwise, the stream will not expand quickly enough to fill the tube. To get a low exit velocity, therefore, with a straight conical tube, necessitated a long tube with consequent heavy excavating expense.

This difficulty was overcome by turning the draft tube in elbow form through approximately 90°. Thus considerable length was obtained without excessive excavation. Also it was found that the 7° flare angle might be exceeded below tail water level. In addition, the water left the system flowing towards the tail race, obviating the necessity for a change in direction at the exit from the tube. It was only necessary to have the upper edge of the draft tube a few inches below the tail water level to get an effective seal for the tube, and much of the increase in cross-section could be effected by lateral expansion, with only a slight increase in the vertical depth of the horizontal part of the tube.

Two alternatives are here presented. One is to start "twining the elbow" immediately below the runner, with gradual increase of cross-section throughout the turn. This enables a large radius of curvature to be used with a low co-efficient of loss in the bend. The other alternative is to have as long as possible a stretch of straight conical section. The sharper turn necessitated is made at a low velocity and the loss due to the bend is therefore small. But it is doubtful whether the extra excavation required by the second plan is compensated for by any marked advantage over the first where efficiency is concerned.[8] In fact, it will be shown later that in one case, at least, the first alternative was better.

In the meantime, the problem of adequate bearings for vertical units was being solved, and turbine design had progressed to a point where one compact runner could be used for even the largest capacity demanded. Even though the generator or other driven machine had to be kept well above tail water, the draft tube enabled the turbine to be set high enough to render a long shaft unnecessary. For these reasons, together with the reduction in the number of turns necessary in the water passages, and the smaller floor space required, the vertical setting once more became popular, and it is this type that will be dealt with hereafter.

While the elbow or quarter-turn tube regained to a marked degree, by conversion into effective head, the velocity head which would otherwise be sacrificed, it only dealt with that component of velocity which was parallel with the centre line of the tube. It is readily seen from an analysis of the off-flow from a runner that there is frequently a whirl component of velocity as well. This whirl is present in low specific speed wheels, even when designed for perpendicular off-flow, (that is, radial flow in relation to the draft tube) at all gate openings other than normal. It is invariably present, often to a considerable extent, in high specific speed wheels. Some means had to be adopted to cut down the velocity of whirl in the draft tube. The elbow type was unsuitable, because the water, through a gyroscopic action, continued to whirl in a near-horizontal plane even after passing the turn, with the result that water flowed out of the draft tube on one side and into it on the other. Furthermore, the whirling action set up such a difference in pressure between the outer wall and the centre of the tube that the water in the centre remained "dead," or even moved upwards. The friction and eddy losses thus set up were bound to have a detrimental effect on efficiency.

To reduce the velocity of whirl, it is necessary only to increase the horizontal radius of the path in which the water is whirling. For it appears that the principle of constancy of moment of momentum or angular momentum applies in such cases.

That is, if m=the mass of the whirling water,
v=the velocity of whirl (tangential)
and r=the radius of the path of whirl (the radius to the centre of gravity of the mass m,)
then mv=the momentum of the whirling water;
mvr=the moment of momentum or the angular momentum;
and mvr is constant.

Therefore, if it is possible to increase r, v will be correspondingly decreased, and the kinetic energy due to the velocity of whirl, being equal to $m \times v$ squared, will be decreased still further. Even more important perhaps than the regain of kinetic energy is the diminishing of eddies and vibrations.

Figure 1 (a) shows a simple elbow tube in transverse section. Figure 1 (b) shows a tube with the same centre line, but of one half the radius at the top. Figure 1 (c) shows the tube obtained by revolving 1 (b) about the verticle axis of the unit.

In practice, the tube (a) would have more flare in the vertical part, but the outline as shown demonstrates how a whirl-regaining tube may be developed out of a simple elbow. The tube (c) is seen to perform the two energy-regaining functions when the dimensions r1 and r2 are considered.

At the top of the tube the arch is $3.14 \times r1$ squared, the same as in the elbow. At any point below the top the area normal to the tube is $2 \times 3.14 \times r2 \times r1$, the minimum value of $\frac{1}{2} \times r1$ being $=r1$. r2 increases gradually at first, until the velocity is considerably reduced, when the increase becomes more rapid. This means that the point of maximum curvature is not reached until the velocity is such that the

losses in the bend will be slight. Where it is possible to increase r2 more than is done in a tube such as (c) r1 should be progressively decreased. This arrangement is very convenient where depth of excavation is limited. The point of maximum curvature must then be placed somewhat higher, but the amount of curvature may be reduced by increasing the spread, the central cone being used to prevent too sudden an enlargement in cross-sectional area. Ordinarily, so far as regaining vertical velocity head is concerned, the central cone may be of any convenient height or may be omitted altogether. The vertical com-

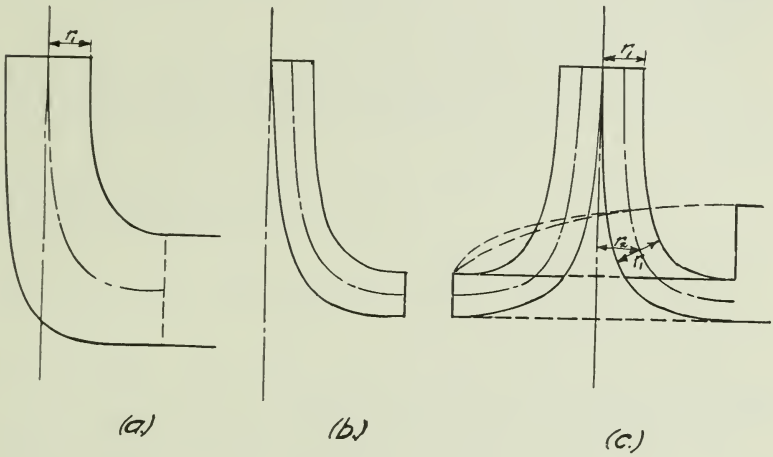

FIG. 1.

ponent of velocity of the water leaving the runner is stepped down just as effectively as in any other tube, and losses may be minimized by careful attention to the bend. The convenience of having the water leave the tube in a horizontal direction is retained.

The whirl component of velocity is also favourably affected by the increase of r1, and both tests on models and experience with actual plants show that the water leaves the tube well straightened out towards the tail race, even when considerable whirl is present. This straightening out may be in a measure due to the sudden removal of restraint from centrifugal action when the water passes the bend, but the great benefit of the increasing radius of whirl about the constant axis is the chief merit of the design. A collecting chamber increasing in area from rear to front as indicated by the dotted lines in Fig. 1 (c) guides the water leaving the tube proper towards the tail-race. As previously mentioned, a dead space or an upward-moving column of water is likely to occur in the centre of the tube when whirl is present. For this reason it is advisable to carry the central cone as high as is structurally possible, even to the hub of the runner, thus avoiding high vacuums, vibration, chemical damage, due to liberated oxygen, and undue strain on the governor. The tube just de-

scribed, and illustrated in Fig. 1 (c) might be called a "Concentric Spreading Draft Tube.

II. Past Types of Draft Tubes

The earlier draft tubes, being designed merely to enable the turbine to be placed above tail water without loss of head, were generally straight cylinders in form. Typical examples of such tubes were those installed in plants at Chaudiere Falls[9] and Columbus, Georgia.[10] As this type did not recover any of the velocity head present at exit from the runner, it is questionable whether its employment brought any real advantage. If the turbine had not been furnished with a draft tube, the losses from the runner to the tail race would have been as follows:—

(1a.) The velocity head at exit from the runner.

(2a.) The difference between the level of the runner band and that of the tail water. With a cylindrical draft tube the losses might be itemized as:—

(1b.) The loss at entrance to the draft tube due to an abrupt change of section.

(2b). The friction loss in the tube, proportional to its length, including that part below tail water level.

(3b.) The loss due to leaving the tube at high velocity and entering a body of comparatively still water.

(4b.) The velocity head at exit from the tube. The losses with the tube when item (4b) was equal to item (1a), were often as great as those without, especially if (2a) was small.[11]

Most draft tubes installed during the past thirty years, however, show some flare, that is, some attempt to cut down the loss due to velocity head. At the beginning of this period, the multiple-runner horizontal shaft became quite popular, and the draft tube must be credited with making the use of such settings practicable. A diagrammatic sketch of one of these layouts (The St. Lawrence Power Company, Massena, N.Y.)[12] is appended as Fig. 2. The head on this plant was 35.5 feet. Three pairs of inward-flow horizontal turbines were installed on a single shaft, direct connected to the generator, and three shaft tubes were provided, one for each pair of turbines. There was a tendancy to "elbow" the tubes, though not through a full right angle.

The earlier draft tubes presented no serious structural problem. They were usually made of metal plate, and were designed, of course, to withstand pressure from without inward. They were frequently stayed at the bottom, especially when of considerable length, to prevent undue vibration. Even to-day, where any part of a draft tube is not integral with the substructure of the plant, it is customary to use some form of anchorage.

The hydraulic properties of these tubes were probably seldom of much value. With a horizontal setting, such as shown in Fig. 2, there is a 90° bend in the flow at the point of highest discharge velocity. This must cause considerable losses. The increased mechanical strength of the runners meant that one small (and consequently cheap) turbine could

handle large powers. The small outlet area of the runner led to high velocities, which could be stepped down by a straight conical tube only by carrying the tube to a great depth, since the angle of flare was limited to 7°. The replacing of horizontal settings by vertical ones made the head-preserving function of less importance than the energy-regaining functions, as the turbine could now be set just above the tail water level. The quarter-turn tube best met the new demand, because it combined length

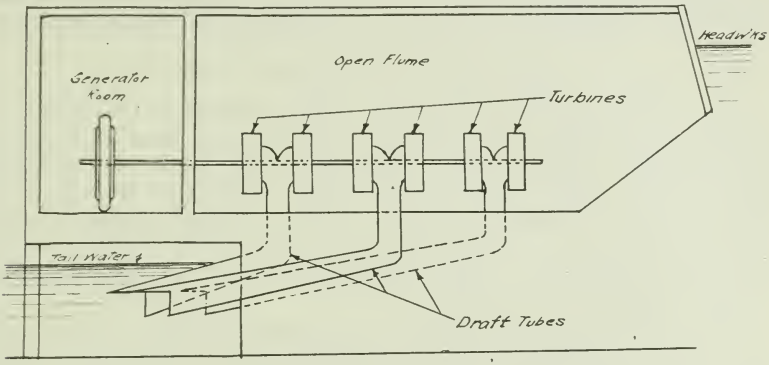

FIG. 2.

of tube (and consequent reduction of velocity) with small depth of excavation. It had the added convenience of discharging in the direction of the tail race.

A notable example of the use of the quarter-turn tube is the Keokuk Station of the Missippi River Power Company.[13] The tubes here are 18 feet in diameter at the top, and turn through a 90° elbow into a horizontal direction. The area at discharge from the tube is 22 feet, 8 inches high by 40 feet, 2 inches wide. The velocity is stepped down from 14 to 4 feet per second. The total available head is only 32 feet, so that the theoretical velocity head recovered represents approximately 9 per cent. of the total head, or some thousands of horsepower in output. At the time of its construction, this plant was considered to represent the best modern hydro-electric practice. A tube of this type is shown as Type L. L., Fig. 6, below.

The quarter-turn tube introduced a new structural problem. The former type usually could be placed suspended from the floor of the turbine chamber and was shaped from steel plate. But an elbow of the size required in most plants was better formed from the concrete of the substructure. The straight conical tube had an open space around it as shown in Type G, Fig. 6, beelow. With the elbow tube, on the other hand, the space below the turbine was filled with monolithic concrete, with the tube cut through it, as it were. The curves in the form-work were somewhat difficult to fashion and necessitated expensive lumber for form surfacing. But the structure was more massive and the roof of the hori-

zontal portion of the tube was as a rule arched. This simplified the carrying of the heavy loads from above. Where the span of the arch was great, an intermediate pier could be inserted to help take the load. This peir also helped, to a certain extent, to straighten out the flow in the exit end of the tube. Special attention was paid to the smoothness of the surface of the concrete, a special mix often being poured next to the form lumber.

An examination of descriptive articles in technical periodicals would warrant the belief that up to the close of the great war, or perhaps a year or two later, the elbow type of tube was considered the conventional type.

III. Present Outstanding Types

Current floating literature contains many descriptions of hydro-electric plants, projected, under construction, or newly completed. So far as this continent is concerned, the quarter-turn tube is now the exception rather than the rule in large up-to-date plants. Post war construction at Niagara Falls, for instance, involving several hundred thousand horsepower, includes only one quarter-turn draft tube. The remaining dozen or so tubes completed or under construction are all of the concentric spreading type.

The many low-head plants now being built throughout the United States almost invariably provided for spreading draft tubes, as do plans of power house layouts submitted as evidence to the International Joint Commission at its hearings late in 1921 on the St. Lawrence Waterway.

The question is, where may a good criterion of recent high-class design be found? The Government Engineers' Report to the International Joint Commission on the St. Lawrence Waterway refers to the Niagara Falls Power Company's plant for an example of high efficiency in hydro-electric machinery.[14] An editorial article in a leading technical journal, discussing the Queenston-Chippawa Plant, points to the "thoroughness with which engineering details have been worked out," and says, "the results assure that the judgment of the engineers was well founded.[15] The strict limitation of water-diversion, the demand for reliability in public utilities and a wholesome rivalry between designing engineers have made these two plants stand out. It appears justifiable, therefore, to turn to Niagara Falls for an examination of present practice.

As mentioned above, the quarter-turn tube has only one representative in the more recent installation. That is the Wellman-Seaver-Morgan tube in Unit No. 1 of the Queenston Plant. The remaining units in this plant are equipped with spreading draft tubes of the Moody design. From what has been said previously regarding the elbow type, there is reason to believe that, where little or no whirl is present, a well-designed tube of this kind may give a high efficiency, perhaps quite as high as a spreading tube. No figures have yet been made public regarding comparative efficiencies in Units Nos. 1 and 2 in this plant, but an examination of the tail race while both types were running at normal capacity revealed no perceptible difference in the degree of turbulence. In both cases the flow seemed quite even, and it is safe to assume that, for the requirements at this plant, there can be little to choose between the two

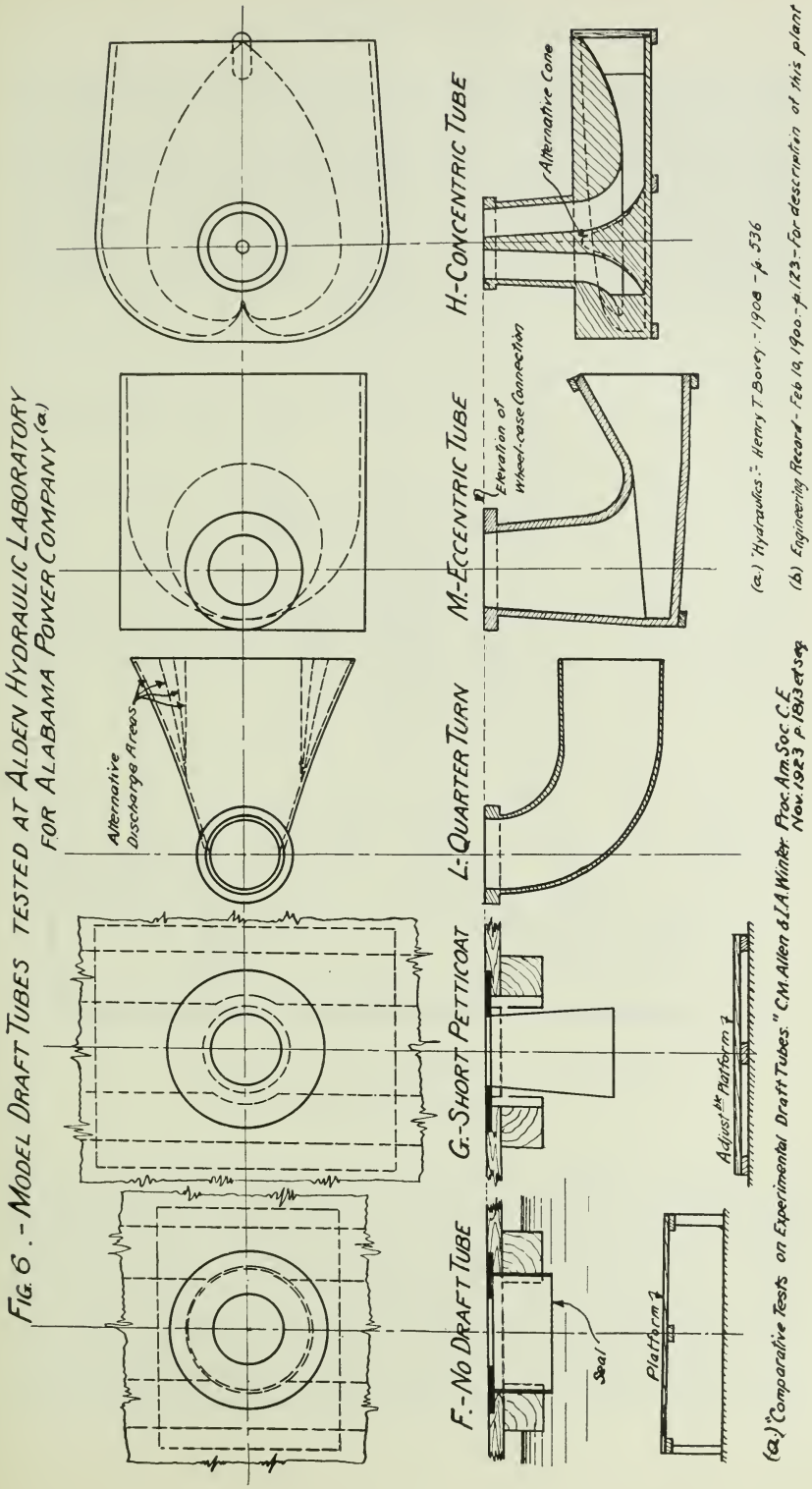

Fig. 6.-Model Draft Tubes Tested at Alden Hydraulic Laboratory for Alabama Power Company (a)

(a) "Hydraulics" Henry T. Bovey - 1908 - p. 536

(b) Engineering Record - Feb 14, 1900 - p. 123 - For description of this plant

(a,) "Comparative Tests on Experimental Draft Tubes." C.M. Allen & J.A. Winter. Proc. Am. Soc. C.E. Nov. 1923 p. 1813 et seq

types; otherwise, those responsible for their selection would certainly have discriminated.

At the Niagara Falls Power Company's Plant, a comparison may be made between the two most notable types of spreading tubes, namely the "Moody Spreading Draft Tube" and the "White Hydraucone Regainer." Here two units side by side and identical in other respects have been equipped one with each of the above tubes. Published results of efficiency tests show two curves, which, if they do not actually coincide, are still too close together to say which tube is preferable.

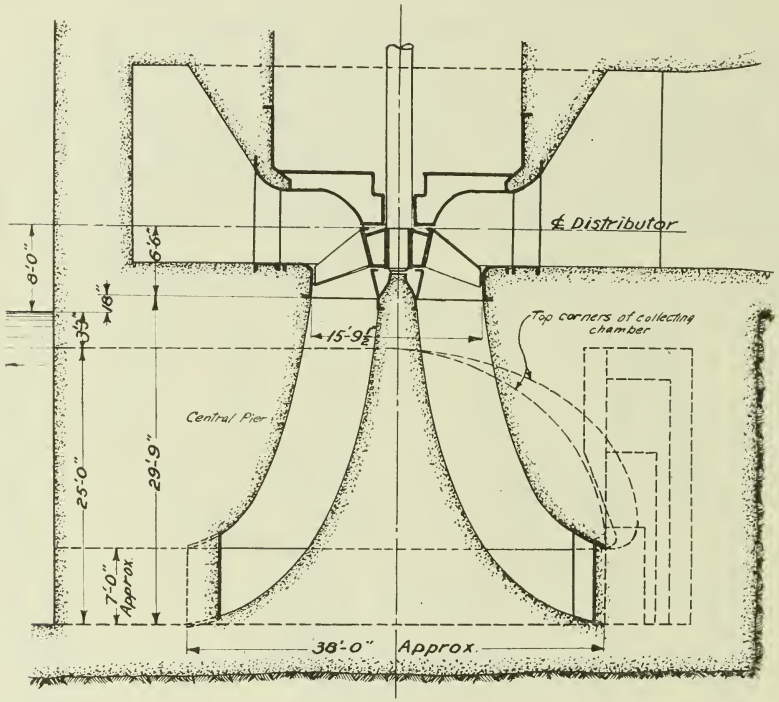

FIG. 3.
A RECENT INSTALLATION[6]
WITH HIGH-SPEED RUNNER

These two designs, the Moody and the White, are at present the outstanding forms of draft tube on this continent. The two types as built usually look much alike, but each inventor claims a different underlying theory. The Moody tube is intended first to turn the water from the vertical into the horizontal direction along the most satisfactory curve. This curve "partakes somewhat of the nature of a parabola.[16] It begins as a continuation of the vertical, ends horizontal, and the point of maximum curvature is kept as low down as possible, so that the sharpest bend will be turned at a low velocity. The upstream end of the curve is at the

runner outlet and the downstream end is fixed by the available depth and diameter. The velocity along the tube is gradually stepped down by increasing the mean diameter of the annular ring, which forms the cross-section of the tube. The rate at which it is stepped down is fixed by the runner exit velocity, the tail race velocity and the length along the tube. The central cone is essential as the inner boundary of the annular space. The action of the tube is said to be improved by bulging the annular space just before the maximum curvature is reached. Whirl component of velocity is dealt with on the principle of constancy of moment of momentum already described. A collecting chamber is provided to conduct water from the rear part of the tube around the tube to the tail race side. This chamber increases in section from rear to front in proportion as the outlet area of tube discharging into it mounts up. A Moody tube is shown in Fig. 3.

The "White Hydraucone Regainer" is claimed to be developed from the behaviour of a smooth cylindrical jet of water impinging on a flat plate.[18] It is known that such a jet on striking the plate flattens out without any apparent turbulence into a horizontal path. A central cone is not necessary in the carrying out of this theory, but its presence would tend, no doubt, to prevent any "dead water" or upward movement in the centre of the tube when large amounts of whirl are present. A central cone is provided in some White-designed tubes. A collecting chamber of similar

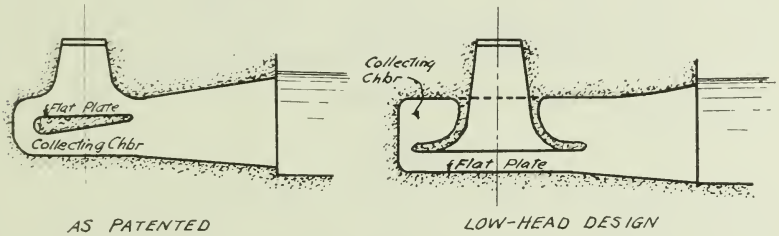

FIG. 4

WHITE HYDRAUCONE REGAINER[6]

shape to the Moody type, but of constant cross section, is sometimes provided above the outlet-section of the tube. Or. if the excavation is permissible, a collecting chamber may be placed under the flat circular "table" which is the floor of the tube proper. The White Hydraucone Regainer with both types of collecting chambers is shown in Fig. 4.

The chief structural problems involved in the spreading draft tube are two in number. The first is the question of adequately reinforcing the bell (the flaring wall between the central tube and the collecting chamber) and the slab from which the bell is suspended. The bell is often of great

weight, and, at the same time of awkward shape. The load from the lower outer tip must be carried in to the sometimes thin wall which forms the bell on a level with the collecting chamber. Then the whole suspended weight must be transferred to the slab above. The slab itself must carry the whole weight of the power house between main piers and the clear span may be as much as 40 feet. A further handicap is imposed by the fact that the slab has a large opening of diameter as high as 15 or 20 feet in the centre of it. The reinforcing problems involved are quite intricate, calling for a fresh solution in each installation.

Figure 5 shows how the problem of reinforcing the bell was met in the Moody spreading tubes at the Sherman Island Plant of the International

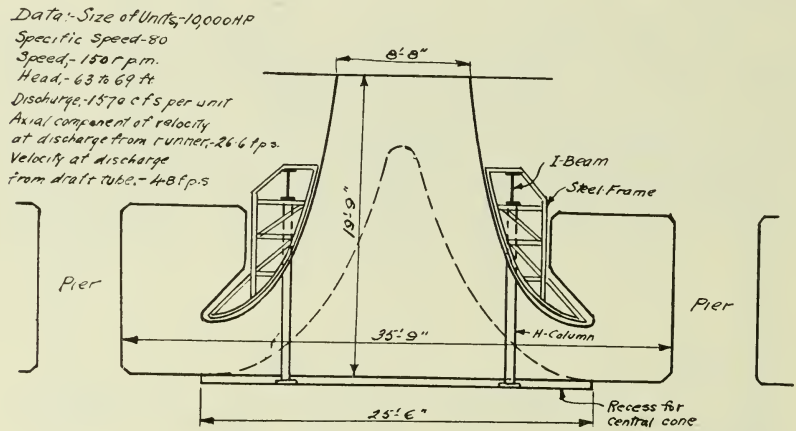

FIG. 5.

Company. In the construction of these draft tubes, twelve structural steel frames (two of which appear in the figure) were hung from a square formed of four 24-inch I-beams. This structure was carried on 8-inch H-columns as indicated. In additional to this structural steel vertical reinforcing the bells have circular reinforcing of the conventional type. After the tubes were completed, the four columns were cut off and removed. This design greatly simplified not only the problem of reinforcing the tubes, but also their construction.[20]

The figure also shows the wide span between supporting piers. This span is usually bridged by a heavy network of reinforcing steel. To carry the heavy loads occurring in some plants, very heavy construction is necessary, as at the Queenston Plant, where the slab is about ten feet thick.

The second structural problem to be met is that of reinforcing forms. A large quantity of lumber is needed. It must be of good quality (and

hence expensive) to stand the large amount of bending and fastening necessary. As a rule, the lumber can only be used once and the carpenter work must be of a high order. The work of setting up the forms and of pouring must be carefully planned beforehand.

Spreading draft tubes are usually formed of concrete, although it is possible in smaller units to have them of steel plate, stayed at the bottom. One such installation is that of the Hydro-Electric Power Commission of Ontario, at Dam No. 8 on the Trent Canal. Here White Hydraucone Regainers made of steel plate are being supplied by the Canadian Allis-Chalmers Company for the three units.

What amounts to a survey of modern draft tube design is covered by a recently published paper on "Comparative Tests on Experimental Draft Tubes" by C. M. Allen and I. A. Winter.[21] These tests were made at the Alden Hydraulic Laboratory for the Alabama Power Company in 1922, in connection with the Mitchell Dam plant. They covered twelve models which are listed in table 1, below.

TABLE I.—EXPERIMENTAL DRAFT TUBES

Type Letter	Type	Designed by
F	Short Petticoat.	Built in Laboratory to represent no tube.
G	" "	" " "
C	Quarter-Turn.	Hydraulic Turbine Dept., Allis-Chalmers Co.
D	" "	Alabama Power Co.
L	" "	" " "
E	Eccentric.	Hydraulic Turbine Dept., Allis-Chalmers Co.
J	"	" " " Wellman-Seaver-Morgan Co.
M	"	Alabama Power Co.
A	Moody Spreading.	I.P. Morris Dept., Wm. Cramp & Sons.
B	White Hydraucone.	Hydraulic Turbine Dept., Allis-Chalmers Co.
H	Concentric.	" " " Wellman-Seaver-Morgan Co.
K	Moody Spreading.	Modified design of Tube A.

The tests covered one specific problem only, but, owing to the extreme care exercised, the results, while not final, are of considerable value. It might be difficult to say which tube was best suited to the conditions designed for, and each tube probably had its merits. The tests do show, however, that no investigation of a water power plant may be considered complete without due attention being paid to the design of the draft tube.

The tubes listed in Table 1 have been grouped according to type. The "Eccentric" tubes, as their name implies, are based on the concentric tube, but have their lower part moved out towards the tail race in order better to meet structural conditions. They may also be considered as

quarter-turn tubes with the horizontal portion flattened and widened. The tube type which gave the greatest efficiency is shown in Fig. 6, and the efficiency curves for the performances of these five tubes are shown in Fig. 7.

The best result was obtained with a concentric tube (H) with a central cone extending to the top of the tube. Tube A also gave slightly

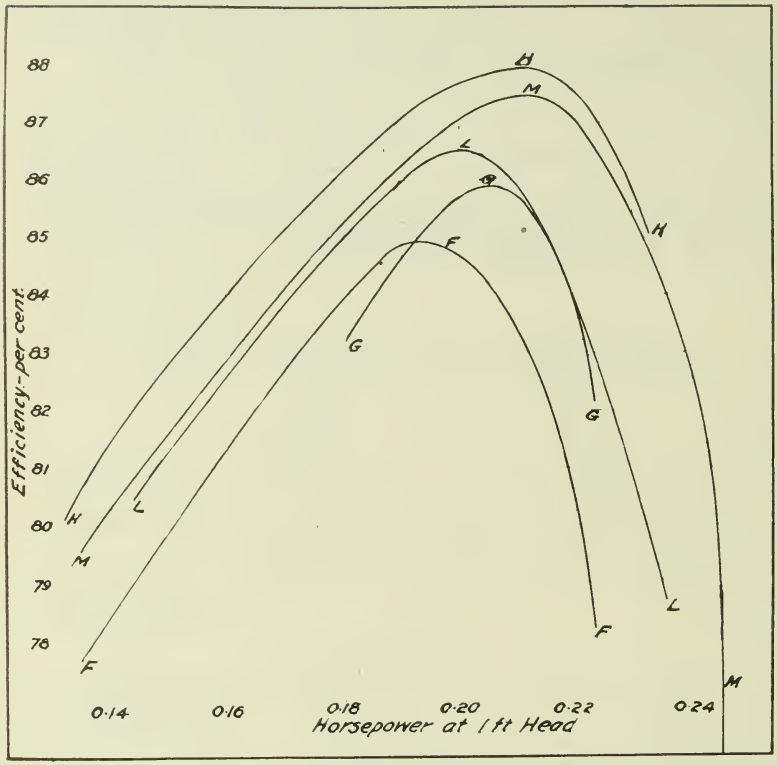

FIG 7

BEST PERFORMANCES OF MODELS IN FIG. 6.

(4) "The Hydraulic Turbine in Evolution." H.B. Taylor & L.F. Moody Mech. Eng.r Vol. 44 p. 633 et seq.

better results with a high cone. Low cones, tested with tubes, A, B and H show no advantage over a flat plate except to improve the characteristics of the individual gate-opening curves. These results, no doubt, indicate that a high central cone is a desirable feature in a tube of this type.

It was found in the case A, E and G that a variation in the height of the throat opening affected efficiency. Enlarging the bell in tube A, and extending downstream the horizontal discharge opening in tube E, had beneficial results. Increasing the length of the vertical barrel in tube M

made no appreciable difference. The discharge area was varied with tube L, and the results showed that it was possible to make the discharge area too large to secure the best results.

Fluctuations in draft tube pressure were found to increase as efficiency increased. The differenc in pressure between the outer wall and the centre part of the tube was measured in tube A. Due to the centrifugal force of the whirling water, a piezometer on the outer edge of the tube just below th runner recorded a positive pressure of 6 inches of water. A centre piezometer, on the other hand, showed a vacuum of 7½ inches of mercury.

Of the quarter-turn tubes tested, the most efficient had no straight conical section at the top, that is, the curvature started at the top of the tube. In the other two elbow tubes there was some straight section and smaller radii of curvature.

In general, the results enumerated may be used to determine how far it pays to go in complexity of design, bearing in mind the greater expense and structural difficulty of the more complex tubes. The runner used throughout the test was a 10½-inch model of a 130-inch, 24,000 horsepower runner, and had a specific speed of 66.7. But tests on runners of different types might reveal somewhat different results, and the selection of the draft tube best suited to each type of runner is still to be considered a specific problem in itself.

IV. Present Day Tendencies

The persistent demand for more electrical energy has led those interested in hydro-electric development to turn to every possible source for water power. Where formerly only visibly high heads appealed to the layman as sources of power, even he is beginning to realize that the smallest drop in a flowing stream represents energy "running to waste." To put it in terms of the equation for power, i.e. $P = QH$, where formerly a large "Q" or a large "H," or both, were considered necessary for an economically sound development, it is now a question of any "Q" with any "H" being investigated as possibilities. Plants are being built now where ordinary "run of river" flow would account for but a small part of the output for the greater part of the time. Water is impounded wherever possible, from flood season and from flow at times when the demand is low, as on a Sunday. The water is then doled out to the plant as needed. The great necessity for economy under such conditions demands flat efficiency curves. In other words, it is not sufficient that an installation be remarkably efficient at rated load, but it must be highly efficient over a large range of loads.

Turning to the curves in Fig. 7, the advantage of type H over type L. for instance, is not so much in the fact that type H reaches 88 per cent. efficiency as against L's 86.5 per cent. But, selecting as a base an efficiency value of 85 per cent. the curve for H is above this line from 0.17 to 0.23 horsepower. L is only above from 0.18 to 0.215. or less than 60 per cent. of the range of H.

Draft tube design has something to do with attaining this object. Even when a runner is designed to give perpendicular off-flow at rated

load, there is whirl present at all other loads, which exist most of the time. This energy of whirl is best regained in a spreading draft tube, so this type is most suitable where economy of water is most essential.

Turning to the question of low heads, the propellor type runner which has been developed for such installations, always imparts whirl to the water in the tube, sometimes to a marked degree. Here again a spreading tube is necessary, even though it may not recover axial velocity head to a greater degree than other types, because only a spreading tube can abstract efficiently the energy of whirl.

Both due to the economy of water and better adaptability to low heads, the spreading tube appears to be supplanting all other types on this continent. Each plant requires a particular design, and in larger plants the design is usually evolved from tests on a model runner in a laboratory. Most engineers, however, who have studied the matter recently, express the view that it will be possible to arrive at some set of rules for draft tube design which may be adapted to any plant of which the remaining features are known. So far, the only points of design to which evidence leads as final are the desirability of a high central cone in the tube, reaching where possible to the hub of the runner, and the setting of the turbine very close to the tail water level. The former feature has been adopted for Units 6, 7 and 8 of the Queenston plant, whereas previously designed units had a lower cone. The latter point is noticeable in all recent installations, especially of low head.

A horizontal shaft arrangement, especially when the turbine is direct-connected to an electric generator is of advantage from the standpoint of first cost of machinery, accessibility of parts, ease of erection and inspection, and by reason of having only journal bearings in place of special thrust bearing.[23] Occasionally the possibility of a return to the horizontal type of setting is mentioned. Should such a thing ever appear desirable, the usefulness of spreading draft tubes will not be impaired. There is nothing in the design of the tubes in use to-day which would prevent them from acting just as efficiently if they were turned through 90° about the turbine connection. This has been demonstrated by tests, as has the fact that a spreading tube will operate quite as efficiently upside down as in the conventional position.

In Europe, the earlier developments in the draft tube were along much the same lines as those on this continent. The main difference is that the spreading tube has not yet attained the same degree of popularity in Europe, although it is known there. With considerable projected development on both continents, however, a few years will show whether the final word has been spoken in draft tube design.

V. Some Special Devices

Everything that has been said heretofore has related to inward-flow reaction turbines. A device called a "diffuser" was sometimes fitted to outward-flow wheels of the Fourneyron type. (See Fig. 8.) The diffuser furnished a gradually enlarged passage through which the velocity of the water as it left the wheel was so gradually reduced as to enable the velocity head to be utilized in the wheel.

Diffuser fitted to Outward Flow Wheels.

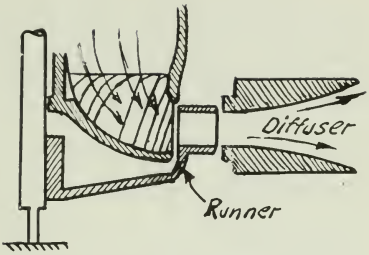

FIG. 8

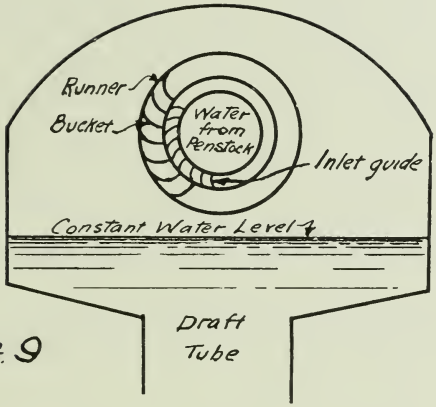

FIG. 9

Device Applied to Girard Turbines.

Moody Ejector Turbine.

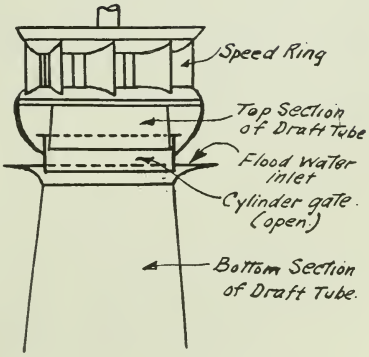

FIG. 10

Impulse wheels cannot be operated satisfactorily under water and must be set free of tail water at all times, and draft tubes are not usually employed. But as impulse wheels are used only under high heads, the loss entailed by keeping the wheels clear of the tail water is inconsiderable. However, the Platt Iron Works Co. has applied a device to a Girard turbine that is strictly speaking, a draft tube. (See Fig. 9.) A vacuum is established and maintained below the wheel in such a manner that the water will not come in contact with the wheel. The water level is held at an established level just below the wheel, which is thus permitted to use the whole head except for the small clearance between the wheel and the water surface in the draft tube. This design has the disadvantage that it is very difficult to regulate the level in the draft tube through all changes in load and tail water level, and it is not in general use with impulse wheels.

A device of which more may be heard is the "Moody Ejector Turbine."[25] (See Fig. 10). This turbine is designed to overcome the loss of output due to the raising of the tail water during flood periods without a corresponding raising of the headwater level. It makes use of some of the flood water which would otherwise be "spilled" away. The apparatus consists of a turbine of normal type, but an annular opening is made in the wall of the draft tube just below the runner, the amount of the opening being controlled by a cylinder gate. When the head is normal the gate is closed and the contour of the draft tube is unchanged. When the head falls off, due to a rise in the tail water level, the gate is opened and a jet of water is allowed to enter the tube at high velocity without passing through the runner. The turbine then operates under a head made up of two parts; first, the conventional head measured from head water to tail water (less frictional losses) and second, the "suction head" produced by the jet of water admitted below the runner.

The Ford Plant at Troy, N.Y., furnishes an example of the versatility (if such a word may be used here) of the spreading draft tube. It has already been mentioned that such tubes will operate successfully on a horizontal axis or upside down. But at Troy there is a White Hydraucone Regainer fitted to a large propeller-type runner in a siphon setting, which is designed to operate under a head which, owing to floods and tides, varies from 4 to 17 feet. It would appear safe to assume, then, that the spreading type of draft tube will meet any possible demand upon it.

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Old School

1901 — 1911

That magic word, "School Spirit" is on the lips of every loyal School man many times during his term here. Nothing can promote a true realization of what School spirit means, where and how it originated and its immense effect on the fortunes of everything connected with School than the knowledge of what those who have gone before us did as undergraduates.

The reminiscent letter section of Transactions has always constituted some of its most interesting pages, and the letters which follow are no exception. We have been fortunate in receiving reminiscences from several men who "did things" in their student days, among them Mr. A.T. C. McMaster, one of the composers of the "Psalm of Life." The history of this unique song is something which every School man should know.

But enough of this preamble! Let us lose ourselves in yesteryear and forget to-day for a time.

A. T. C. McMaster—'01

Your request for recollections and reminiscences of my Class at S.P.S. makes one feel that he should be either very old or very famous. I have the distinction of neither, being on of the very few of the Class of '01 still equipped with a full head of hair which has not turned gray.

But why has this not been general? Probably because '01 was early recognized as the hardest working Class that had entered S.P.S. for many years. And, of course, those who work hard must play hard, with the result that we were strongly represented on the School and 'Varsity football and hockey teams by such men as "Doc" Jackson, John Henry, and "Biddy" MacLennan, and had such skilful fencers as George Bertram, Dave Forkers and Billy Duff to bring cups and medals to the School.

Among the well-remembered incidents of our time will be the Battle of the Racks, in which we carried off the bicycle racks from the Arts and the Meds. on several occasions, in spite of their superior numbers. After one of these scraps, when we had captured and tapped some of the big chaps of one of the other faculties, I was writing it up as School Editor for "Varsity," and saying some things that I feared might make it disagreeable for Dean Galbraith, whom we all greatly respected. So I took my copy in to "Johnny G." and showed him what I had written, telling him I would revise it if he thought wise. But he just laughed heartily and said to go ahead and print it, but to be certain he had not seen it.

There was always a lot of fun when the tap was running, and for many years the plaster was off the ceiling in the basement of the old red

school where one triumphal passage was stayed but an instant as a long arm was reached up and pulled down a gas jet and its connecting pipes and plaster.

It was in our final year that Professor (now Principal) Hutton caused the Psalm of Life at S.P.S. to be written. This was due to his berating the writer because the School had only a yell and no special song to sing like the other faculties had on the occasion of the conferring of a degree on the then Duke of York (now His Majesty King George). But that night, with Dave Forkers, Max Sauer and the writer, the Psalm had birth, and the School had its song for the special Convocation, which was held in the East Hall of University College, the largest room then available.

A further incident of that same occasion was when Sir Wilfred Laurieer, urged by the student body on the lawn for a speech, made one of his best ones. He said simply, "Gentlemen, this is not my show."

It was in our time that the School became of age and celebrated this event by becoming the Faculty of Engineering of the University of Toronto.

It was also in our time that the growing pains began which took their first outward form in the Mining Building for which we memorialized those in power in Queen's Park. But ever as the Faculty has grown we come back to the old red school and, in the terms painted by vandal hands upon its steps one Hallowe'en, we greet it "Home, Sweet Home."

Yours sincerely,

A. T. C. McMASTER.

E. W. Oliver—'03

I have your letter of the 1st inst., requesting a few memories of the days when I was a student at the School. I use the word student with some hesitation, as the only one there now who would permit the use of the word is Professor C. H. C. Wright. His interest in the use of the term would be entirely confined to the draughting room, as I know that he thought that back about two hundred years ago some of my ancestors had some ability on a drawing board.

When I arrived at the School the first person to cause a chill to run down my back was our good old friend "Prof." Graham. However, I was comforted by finding myself standing next to Peter Gillespie, who wanted to know what my name was and the name of the fellow beside me. My first impression was that Peter was the Chaplain of the School.

To enumerate the many incidents between that time and my graduation, involving "scraps," "lockouts," paying fines and atonements of various natures, would involve me and some others who are now regarded as respectable citizens, in a recital of sin and degradation that I am sure President Falconer would suppress because it was before the present Christian Era introduceed by him. However, I wouldn't have missed

it for anything—it broadens one wonderfully. Thoughts of those days bring to mind many affairs which would precipitate strife in Europe today, in which parts were played by Biddy McLennan, Baldy Campbell, Alf. Burwash, Bob Bryce, Gig Ramsey and that wonderful character, the late Fred Miller, whose death was a terrific blow to all who knew him.

Then came our post-graduate year, in which we had five students, consisting of John McFarlane, Peter Gillespie, Norman Wilson, J. C. Gardner and myself. I remember one day we were running a test, and I was on a tank near the ceiling in blue jeans and none too clean, when one of the boys announced that a young lady wished to see me. Up to that time a lady had never been nnown to enter the doors of the School, and I was naturally not inclined to believe them. However, I finally came down, and sure enough a very beautiful young lady was there. Someone had told her that I could get her tickets for the Ruby dance. Yes, she went to the dance.

The staff of the School at that time was composed of a very fine set of men. I shall always look back with great pleasure on my association with them. Without extolling them individually, the three senior members, Dr. Galbraith, Dr. Ellis and Dr. Coleman, were men of such outstanding ability that anyone would feel proud to have had the privilege of being a student under them.

While I am not following the profession of Engineering now as a vocation, I will always regard my student days spent at the School with great affection.

Yours truly,

E. W. OLIVER,

Manager, Canadian National Railways, Electric Lines.

W. J. Smither—'04

Replying to your request, I take pleasure in recalling a few of the incidents occurring during my student days, 1901-05, at the Old School.

The class of 1904, entering the Old School in the Fall of 1901, were soon initiated into the form of warfare carried on between the Meds. and School. Early in October 1901 the famous flagpole scrap took place between School and Meds. I say famous for it was "some scrap," and our present King, then Duke of York, was the cause of it all. Of course it was something like the story of "The House that Jack built." Had the Duke of York not been coming there would have been no flagpole erected.

The Duke of York with his wife, the present Queen, was making a tour of the British Colonies and was to visit Toronto. The University of Toronto made preparations to confer on him the Degree of L.L.D., and in these preparations a nice new flagpole was erected on the lawn in front of the Biological Building, from which the royal standard could be flown. The Duke was to enter the University grounds from College Street by the roadway which then ran directly to that street. Well, the flagpole was placed in front of the Biological Bldg., and the next morning, all

that remained of that pole on the Meds. ground was a stump showing some clever axe work.

The main part of the pole was standing in front of the old School on School ground, this being the proper place for it, so School thought, but the Meds. naturally disagreed with us and so a scrap was off to a nice start. First the Meds. tried to take the pole back, but we held the pole and in order to keep it for sure took it down and placed it in the basement. Meds. sent us a challenge to fight it out on the front lawn, and there we lined up with the pole. At least it was a pole but not the original one for by this time the University authorities had commandeered the flagpole. School got another pole about thirty feet long to serve in the scrap.

"Johnny" and Dean Reeves of Medicine did everything possible to prevent the fight by exxhortations, threats, and promises. They at last promised the gift of a Cup to be played for yearly in Football this being the move to stop all scraps in the future. All their efforts proving futile the scrap was started by the Meds. rushing in on School who held the pole. Of course School won, but Meds. got the pole.

We, the class of '04 being the poor innocent freshies found the School all locked up after the scrap, so we had to find our way home without hats, coats or keys etc., which we had left in the School for safe keeping. Our torn clothes and covering of mud caused a great deal of embarrassment for ourselves and amusement to those whom we met.

The session 1902-03 was a great athletic year for S.P.S. We captured six championships these being as follows:—

Individual Inter-college championship by W.R. Worthington.
Mulock Cup.
Jennings Cup.
Senior Inter-College Association Football Championship.
Intermediate Inter-college Association Football Championship.
Inter-college Track Team Championship.

In those days all students turned out for the games or it meant painting and the tap for those who did not.

Our Annual Dinners were a big event in those days. A special Committee was elected to run the Dinner and it was always a hot election, for the Committee entertained the guests the day of the dinner. Our guests, who were representatives from all Colleges and Universities in Toronto, also from Queens and McGill, were driven around the city in a tally-ho, given a lunch at Mc Conkey's and taken to Shea's for the afternoon. They were then well looked after until the Dinner, and so tuned up to give us a good speech.

It was in the Fall of 1903 that we had the great vote by ballot, as to whether our dinners should be wet or dry.

The Engineers' Corps was started in 1901. It was known as Number 2 Company and was under then Captain, now Colonel W.R. Lang. The rest of the Company were all School men.

On Saturdays we would have Field Days, along the Humber River building a bridge with poles and ropes across the stream. One of our best stunts was tying a cow and extracting the milk for our lunch.

When I look back to my Student days at the Old School I see so many outstanding events that time or space will not allow me to repeat them.

Yours truly,

W. J. SMITHER, 1904.

T. R. Loudon—'05

To pick and choose from the events of a decade of University life in order to relate them to a critical reader might well be the task of an author who wished to write a volume. And if the writer in the following condensed article appears to deal with that which to the very serious minded may now seem frivolous, there remains the execuse that at gatherings and reunions of those same senior graduates, it is the re-enacting of such events in wordy tale that constitutes of joy of the meeting. What graduate who holds the memory of his University career dear but who thinks of some escapades as the binding cement of friendships formed in those days when lectures palled and the thought of exams raised the red mists of terror.

Then at the risk of being accused by one's colleagues of sympathy with riot and disorder, the writer cannot refrain from comparing unfavorably the present day "Initiation" with the far pleasanter relations that existed in the past between the serious minded Sophmore and the innocent Freshmen. True, it is that nothing of an organized plan as to time and place of meeting was ever followed in the olden times, and the numbers that constituted a quorum were very elastic. Indeed, many very pleasant events took place between groups of five or six who happened to meet in a friendly spot—as for instance on the occasion after which the windows of one of the basement rooms in the old "School" building were strongly barred with steel rods.

For it seems that some of the disputants fearing official intervention with their labours of explaining the workings of a tap to a few freshmen, locked the door of the room. But so much noise did they make that a member of the Faculty, when no notice was taken of the demand to unlock the door (no one inside being able to hear the request) ordered the door broken open. The contestants, however, suddenly realizing their perilous state during a lull in the battle, quietly stole out the window amid the noise of the breaking lock, and so some say, came around to help the storming party and remained to express great amazement when finally no one was found in the room! Bars were placed on the windows after this, but the birds had flown and the cage has never caught others.

The great increase in numbers at the University as time went on has been the undoing of all such little "affairs"; for it has been known to happen that having finished with one another, the members of a comparatively small dispute have combined and gone afar into foreign lands and waged war on too large a scale to escape "official" notice. Such an event was staged on March 17, 1904, when the whole "School"

went to the rescue of a few of its innocent second year members who had been waylaid in the Main Building, and, so it was said, were being subjected to indignity! A truthful historian must perforce relate that these same "Innocents" were accused of having used "green ink" to decorate some of their Arts companions, but of this one really cannot say, as the evidence, if any, must have been obliterated in the ensuing fray! Such a battle as was staged! Water is said to have flowed six inches deep out the main door! As to the correctness of this, the writer cannot say —not having measured the stream; but certain it is that fines were eventually paid for the disappearance of about four lines of fire hose, so that perhaps some budding hydraulic engineer may be able to calculate whether or not the discharge of these in the building could have produced the stream mentioned!

With the increased registration also passed another pleasing event that characterized "School" life at the early part of this period; namely, the Annual Excursion, when the whole undergraduate body visited each year one of such outside centres as Niagara Falls, Buffalo, Peterborough, etc., where a profitable day would be spent inspecting the manufacturing and engineering interests

There is at the present time a secondary battle cry to the old "Toike Oike" which emphasizes the fact that the ensemblage are Engineers and can do sundry thin' to forty helpings of liquid refreshments, etc. This "yell," while it is not the particular property of "Toronto," first made its presence felt during the procession from Rosedale Field to the King Edward Hotel after the memorable 11-9 last minute victory of the "Toronto" ruby team over the invincible Ottawa Rough Riders. As usual, the large majority of the head of the improptu parade were "School" men, and this "yell" broke out time and again and has never been in disuse since, even in spite of the present difficulties of obtaining the wherewithal to accomplish the boast contained therein.

Seriously speaking, the great event of this period was the re-organization of the University in 1907 when the School of Practical Science became the Faculty of Applied Science and Engineering, manifesting in the greater University, the spirit of one, the memory of whom shines now and evermore—the late Dr. John Galbraith, founder of the "School." About this time the increase in registration was beyond the capacity of the buildings. The present Mining and Mill buildings were the first to be provided and since then the remaining buildings have come one by one—generally well behind the demand in point of time.

Did the undergraduate of this period have as "good a time," as the saying goes, and did he receive the same training as his present day brother? To answer this question would require wisdom beyond the present day limits; certain it is that the "old grad" always says, No! but since the writer has no intention of being called an "old" grad, his only reply is that the present day student has far better facilities for having a good time, as witness Hart House. As regards education, there are fewer facilities for personal contact between student and professor now, although there is more and better equipment in laboratories.

THOS. R. LOUDON.

A. D. LePan—'07

'07—magic term to that favoured 200 who started at the "Old School" in 1904 with the opportunity of finishing their diploma heat in '07 and their degree final in '08. At this time a student could, by fooling the examiners, obtain a diploma at the end of three years and proceed forth as "Grad. S.P.S." About this time the diploma was abolished. Strange, but I think we have always rather considered ourselves of the vintage of '07 rather than '08. I suppose it was the enthusiasm of the old "School" spirit which, perhaps at that early stage, had hardly been transferred to its foster mother, the University. Times have changed somewhat since that period and, while the "Schoolman" of to-day has lost nothing of his love for the "Old School" he has included a loyalty to the University. It is well that this is so. "Daughter, am I in my mother's house but mistress in my own" perhaps very well explains it. It might be urged that the "Schoolmen" have not always subscribed to the first part of the quotation.

When I say that '07 was the most worth while year that ever honoured the "School" by its presence, I am saying what every man will say of his own year. Isn't this rather a striking tribute to the friendship formed during those four wonderful years? Perhaps, for the great majority, the most wonderful years in life. What limitless possibilities—what power—what assurance—what importance—in our own eyes. Just one illustration:

One beautiful spring morning Dr. Ellis arrived a few minutes late for a 10 o'clock lecture in the Mining Building. The class had been passing time by "passing him back" and were caught with the goods in the air. To enable the lecturer to quietly admonish the guilty—those caught—in his own fatherly way the class was dismissed. Satan certainly found mischief for those 400 idle hands for they immediately went out and started an engagement with Meds. that lasted till 3 p.m. when both sides decided to call it a day.

Meantime, the umpires, the Faculty, in deciding what prize to award the winner and the looser, closed the buildings against us so that their deliberation should be not be disturbed. I am afraid we did not treat the umpires in the most approved manner. We returned to the old Gym and went into conference. Our wrongs—real and imaginary—were discussed and, believing that the best defence is to attack, we drew up certain conditions—I think ten—that the Faculty would have to meet before we would return. I have forgotten what these conditions were and perhaps it is better so but, for ten days, unmolested, we met every morning in our own convention hall and every afternoon I suppose those who had the necessary money went to a show.

But a wise Faculty saved us from ourselves. Dean Galbraith was more than a great engineer. He understood human nature. What did he do? Call in the police, convene the Caput and fire us all? Not at all. He received our ultimatum and said very little. I can imagine though that in his wisdom he smiled. For ten days we were left pretty much alone and allowed to blow off steam till we could no longer operate the

safety valve. Our temperature, having come to normal, we were allowed to continue the study of our chosen profession on the Faculty's terms.

Although not attacked we felt rather proud of having held our position for ten days. Had we not defied the Faculty and got away with it? Some Class! Our vanity was rather shattered when Dean Galbraith, at our Graduating Dinner, confided to us that his class had been out for three weeks.

Perhaps I have over emphasized what, after all, was a very unimportant episode in the life of this class. We were not always foolish. Some worked all the time and all worked some of the time. Perhaps those who got the most out of their four years worked a good deal of the time but found time for play and active interest in Faculty Organizations and their fellows. After all, the rubbing process is an important one in a University education.

And what of '07 to-day? Here, there and everywhere. In the power plant, in the bush, in the mines, in the factory. But wherever they meet there is a thrill, a smile of welcome, and a hearty hand grasp. Nor is this joy of acquaintance confined to students. Dean Galbraith and the late Dr. Ellis, both princes among men, who ruled us wisely and, being strong, understood our weaknesses? And to those who still labour, we extend the hand of appreciation and friendship.

A. D. LEPAN.

T. H. Hogg—'07

The Class of '07 entered the Old School in the Fall of 1904 with the largest attendance to that date. If I remember rightly, the number was around 225, one of the largest years that has ever entered in the Faculty of Applied Science, and while many fell by the wayside, the graduating year was a large one.

Most of us will have a very vivid recollection of the "Amen Corner" and its activities. The members of that group are pretty well scattered. "Coo" Cowper, of Welland, is in Ottawa; Jack Wilson, Freddy Robertson and Jimmy Garrow in Toronto, "Biddy" Anderson was killed overseas in 1917.

Reminiscences of the class of '07 would not be complete without a reference to Jack Stiles. Jack was one of the older men of the year; a man of strong personality, with great ability in presenting his ideas on the public platform. Jack initiated the first debating club of the School, which is still being carried on. He was also one of the leaders along with A.D. Le Pan, Ireland and Frank Ewart, not to mention Les. Rannie and "Duckie" Quance, in the famous '07 rebellion against the authorities, when the whole Class were on strike for a period of a week. The cause of the strike originated in certain doings of "Red" Hutton, who is now located in Hamilton with the Dominion Power & Transmission Company. Stiles is out of engineering now, and is head of the Boy Scout organization in Canada.

The publication of "Applied Science" was initiated in the year 1907 under the able managership of K.A. McKenzie, who had been President of the Engineering Society in '06. The issue of the "Transactions" in monthly form was a very weighty step for the Engineering Society to take, and while the early years were very successful, later it was found impossible to carry on the work, and I note that now the Engineering Society has reverted to the original yearly "Transactions."

During the first two years of the Class we had Dean Galbraith with us, and we all remember with deep affection his gentle personality and many lovable traits. In the last year, however, he was absent practically for the whole session, on the Royal Quebec Bridge Commission; Dr. Ellis acting as his representative as Dean. The executive of the Engineering Society of '08 was composed, among others, of Andy Kinghorn, Herman Hyland and Archie Wilson. This was the year in which Sir Robert Falconer became President of the University, and from which time the School's association with the University began to draw much closer. The Students' Council was organized in this year, and I understand that this organization is now doing a great work in tying together the various faculties and in handling student discipline throughout the University. There have been many changes in the staff since that time. Dean Galbraith, shortly after graduating of '07, passed on. and later Dean Ellis. John McGowan has retired from the staff, and many new and younger men have been added.

The University residnces were being built in 1908, and I had the pleasure of being the first house master of the North residence on its opening in 1909, when I held the position of demonstrator along with Bill Swan in the Department of Applied Mechanics.

The Class of '07 attended the School at the transitory period between the Old School days and its present close association with the University, as the Faculty of Applied Science and Engineering.

T.H. HOGG
Hydraulic Engineer.

And so they have spoken! Their exxperiences, their scraps, their daring escapades, have been perhaps more like our own than were those of earlier graduates, but in reality this only serves to show the gradual change in University Life, which must change, even as all things change.

For their generosity we thank the writers,—may their future reminiscences be ever happy ones!

The "Old Red School"

The Mechanical Building

The Dean's Message of 1924

This issue of "Applied Science" marks another year's progress in the history of the Engineering Society. The officers and members of the Society and those having the publication in charge, are to be congratulated on the excellence of the programme for the year, and in the form in which the papers are published.

The manner in which the interest of the members has been sustained throughout the year, not only in the Society, but in the various Clubs composing it, indicates a true appreciation of the efforts of those responsible for the subjects and for their presentation, and is a tribute to those graduates and other members of the profession who have been good enough to come here to address the Society.

At this stage in the Country's development many of the subjects treated are of vital importance, and it is fortunate that the members of the Society have had the opportunity to hear these addresses, and will now have the advantage of having them in permanent form.

The Engineering Society is to be complimented on such an excellent year in all respects, and may this good work and success continue.

(Sgd.) C. H. MITCHELL,

Dean.

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of the

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With which is incorporated "Applied Science"

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Editorial

April, 1921, was the date of the first Annual "Transactions and Year Book of the Engineering Society" as it is known to the student of to-day. This year the fourth of the new cycle is submitted to the Undergraduates and all subscribing Graduates.

In composing the book an effort has been made to include all papers presented before the Society. All these were not available, due chiefly to the fact that the addresses were for the most part extemporaneous. A goodly part of the technical section is devoted to papers other than the above. For these we are deeply indebted to the authors. Members of the Staff have been particularly generous both in the matter of writing papers, and in an advisory capacity.

The "Old School Section" has been continued to cover another ten years. General opinion seems to be, however, that more recent graduates do not consider their reminiscences of sufficient value to have them published. Thus the number of letters received for the three years of this section's existence has decreased proportionally as the dates have been brought up nearer our own ken.

A record of activities throughout School for the last year occupies slightly less than half the book. This is the more personal

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part of the publication in the contents of which every student should be interested, inasmuch as he has played a real part in School life. To the Graduate the Year Book is a year's history of the "Little Red School" which ever remains dear to him.

Since "Transactions" is a summary of all School events of the year, it necessarily appears when the student is burning the midnight oil for nearly the last time before vacation. Some may even receive it in time to give their copy but a cursory glance before packing it up for the homeward journey.

But no matter when it is read, or where, it is our hope that every man will find in "Transactions" something which interests him, for after all graduates and students alike are members of the Engineering Society; "Transactions" is the official organ of the Society, and as such is their book—may it please them.

SCHOOL—ITS INFLUENCE

That School has an influence which appeals to the highest and noblest in men, no one will deny. Fair play and justice to everyone is the very essence of the manner in which all activities are carried out, whether they be tactics on the gridiron or arrangements for a "Stunt" night.

When did this influence which has resulted in School "spirit" originate? Was it not in those men who first entered School,—men of vision who after training here went out into the world and built as they alone knew how to build! How much we owe to these men and to all the graduates since that time we do not know, but of this we are certain, that the road has been well paved, and it is up to us to profit by their experience.

This influence has made us put every ounce of our strength into the work at hand. It has developed team-play, that most essential element in any organization. It is not always easy to pull cheerfully with the other fellow, but here where we are all pulling for the same goal, the difficulties are relatively few. Out in the business world, however, they are very real problems, and it is men with team play experience, with an analytical type of mind, who are being sought to solve them.

THE MAILING LIST

After a lapse of a year it has been decided to charge a small subscription price for "Transactions." While the Engineering Society approves the idea of sending copies gratis to all graduates who may desire them, it does not feel that it is able to do this under the present conditions. Fifty cents is no great sum, and it is thought that all graduates who retain an interest in "School" and its associations will be willing to pay this for our Annual Publication.

The formation of a complete mailing list has been started this year. Cards have been sent out to one-third of all graduates, starting with 2T3. Another 750 cards will be mailed next year, and by April 1926 it is hoped that a complete subscription list will be on hand.

THE ENGINEERING SOCIETY ANNUAL DINNER

Once again Hart House was the scene of the Annual Dinner of the Engineering Society, the 34th in the series. The policy of the Committee in preferring Hart House to a down-town food factory was vindicated in no uncertain way. After the smoke and fumes cleared away, no less a person than "Pat" Wingfield was heard to remark that he was just as pleased with the 34th dinner as with numbers 30 to 33 inclusive.

The purveyors of nourishment at Hart House tried to excel themselves in an effort to prove that a real dinner could be obtained there, and met with a good measure of success. May they proceed to even higher achievements in the future.

The "paying guests," the student body in general, were present in goodly numbers, and were well supported by members of the Faculty. Everyone present was in high spirits, some even as high as two and one-half per cent. Full justice was done to many choruses which lent themselves to an accompaniment of blows with knives on the indestructible crockery of Hart House.

The entertainment provided was of the usual high order, and the Committee are grateful to those who, with song and verse, filled in the spaces between courses, or between speeches. It is not too much to say, however, that the toast list was responsible for much of the attractiveness of the programme. Toasts to the University, the Faculty, the Profession and the Sister Societies were proposed by Doug. Dow, Tommy Kingston, Paul White and Jack Dymond, and replied to by Professor Young, Dean Mitchell, Professor Loudon and nobody respectively. The operation of the curfew law unfortunately prevented the representatives of McGill, Queen's, and R.M.C. from replying, much to their delight, but much to the regret of their hosts. It might be well here to advise next year's Dinner Committee to lay in an ample stock of time or else to hear from these welcome visitors earlier in the evening.

In addition to the listed speechifying, the assembled multitude were so fortunate as to hear a splendid fatherly talk from Mr. D. B. Hanna, formerly head of the Canadian National Railways. His address contained exactly the right proportions of sound advice, reminiscence, wit and brevity, and was muchly appreciated. The Engineering Society would like Mr. Hanna to consider himself "one of us" on similar occasions in the future.

S.P.S. DINNER COMMITTEE.

TOP ROW:—

W. M. Laughlin (1st Year),
Spence Clark (4th Year)
C. A. Pollock (2nd Year),
A. D. Morton (3rd Year)
F. H. Patterson (2nd Year),

BOTTOM ROW:—

V. D'E. Strickland (Sec.-Treas.),
W. E. Carswell (Chairman),
W. A. Osborne (Pres., Eng. Soc.)
T. M. S. Kingston (4th Year).

The hard-working committee deserve the thanks of all those who profited by their efforts. It is to be hoped that future committees will try to do even better, if they can, and furnish an unending series of dinners, at which those lucky enough to be able to attend will feed well, sing well, and listen appreciatively, and from which the same lucky ones will go away satisfied that School is good for many such an occasion in years to come.

"AMONG THOSE PRESENT."

THE ENGINEERING SOCIETY ANNUAL AT HOME

The annual "At-Home," February 22nd, presented many new features this year, as well as a few neew problems. Hart House was the scene of the festivities, but the weather was against us, several heavy falls of snow making the roads in and around the University absolutely impossible. School men, however, cannot be beaten even by the weather, and turned out in parties of twenty on half-hour shifts for most of the afternoon previous and on the day of the dance, and cleared Hoskin Avenue, which was nearly two feet deep with snow. From the residences to Queen's Park and down to the east entrance Hart House—nearly a quarter of a mile of roadways—was shovelled, making ample parking space for everyone.

Of course it was a success, though a few were frightened away by the snow. As is usual in Hart House, the decorations were the big problem, and the committee spared no effort to make them a success. All the halls and passages were decorated with colored lights, S.P.S. shields and streamers of tinted tissue. The gymnasium was the crowning feature, with its cleverly arranged false ceiling and border of festoons and large shields representing all our own faculties as well as all our visitors. The programmes were rather odd, being fan shape, but the greatest novelty of the evening was the presentation to each girl of a small boquet of roses and narcissus, for the distribution of which we are very gratefull to the patronesses.

W. E. CARSWELL, First Vice-President.

SCHOOL NIGHT AT HART HOUSE

School men maintained their reputation on the evening of January 29 when they staged the second Annual School Night in Hart House; the success of the evening demonstrated the ability of school men to organize and carry to a successful conclusion undertakings in which organization and completeness of detail were then important features.

DANCE COMMITTEE, FACULTY OF APPLIED SCIENCE.

TOP ROW:—

A. B. Bicknell (2nd Year),
J. M. Kilkenny (1st Year),
T. E. Bingham (3rd Year),
B. C. Matson (4th Year),
R. M. Clark (2nd Year).

BOTTOM ROW:—

F. J. Wallis (3rd Year),
T. R. Emerson (4th Year),
W. E. Carswell (Chairman),
W. A. Osbourne (Pres., Eng. Soc.)
A. R. Chadwick (Sec.-Treas.)

The first school night held a year ago was a huge success, and it was felt that to make it a greater success this year preparations should be made early in the year; so at the first Engineering Society Executive meeting in the fall term a chairman was appointed to complete an organization to arrange a programme for the event, this organization to be responsible to the Engineering Society. After serious consideration the committee decided to follow the aims of the originators of this form of entertainment for the student body, in that their would be no charge of admission and that the attendance be strictly limited to members of the Engineering Society, the members of the staff and a limited number of graduates.

On January 29 Hart House was Wide Open

An ultra modern play, entitled "Insomnia," written and directed by Jack Dymond and presented by an all star school cast was shown in Hart House Theatre. In presenting this play the author assumed the role of a prophet and by means of the play depicted conditions as they will exist in our University thirty years hence. "Insomnia," the leading lady, played by Ralph Kerr, is the ultra modern girl, who is registered in the Faculty of "Gold Diggers" at the University. In this future faculty the girls are no longer bored with the study of moderns, but devote their entire time to the study of cosmetics, attitudes and other ways of attracting the male. The hero of the play is the ultra modern youth registered in the Faculty of "Rugby," who is putting himself through college by engaging in the hazardous occupation of running cigarettes across the border to the south, our neighbors, by following the present trend of reform have banned the deadly weed. A chorus of eight male females gave a demonstration of a scene in the "Gold Digger's" laboratory and sang the "Gold Digger's" chorus. The play was clever, well presented and well received.

An excellent programme was presented in the Music Room. Stewart Muirhead was successful in securing the services of five talented musicians who each gavea fifteen minute performance. These, combined with two sections of the stringed instrument club, provided musical entertainment which was well received by a large and appreciative audience.

Many of the best athletes of the University and the city were seen in action, the gymnasts of the University and Central Y.M.C.A. gave a classical gymnastic display and a burlesque with clowns, the performance was repeated once. In the tank, University College and School staged a game of water polo. Mr. Van Valkenburg gave a spectacular exhibition of fancy diving after the polo game. To climax the tank performance a competition of canoe tilting was staged. This feature proved a fitting and exciting climax to an excellent exhibition.

Not being content with showing the different departments of Hart House in full swing, the years and clubs operated a number of side shows along the corridors and in the common rooms of the south wing, which would rival a modern circus. Here, barkers competed with each other in attracting people to witness the features which were being presented—nigger ball throwing stunts and miniature bowling alleys for those who wished to win valueless prizes by feats of physical skill; an art gallery and museum for those who wished to feast their eyes on beautiful paint-

ings and modelled forms; a radio concert from all parts of the world; famous imported musicians dispensing jazz music and parodies for those who wished a modern form of entertainment; the followers of Sir Oliver Hodge were mystified by the physic power of the recently discovered animal, "Delphi Oracle," who with aid of its keeper and the use of fluorescent tubes, induction spark coils and other products of inventive genius, was able to answer any question pertaining to the living or the dead.

Refreshments were served in the great Hall and in the alcove opposite the S.E. door. Hot dogs and coffee were on order in the great hall and liquid refreshments were dispensed in the alcove, here the chemical club with the aid of an array of stills and vats gave an exhibition of the manufacture of the forbidden fluid, but alas! all that was served to the mob that surged around was harmless orange crush. In the alcove, Eskimo pies were also served and the public were shown the secret process of manufacture of this frozen product. A row of jars containing chocolate, milk and sugar and a hopper full of wrappers were arranged over a mysterious machine. When a purchaser wished a pie and placed a ticket in the operator's hand a full fledged Eskimo pie was ejected automatically from the machine. This booth was very original and well directed, and great credit is due to Mr. Bayley and the Chemical Club for its originationd and operation.

There was not a dull moment in the whole evening. Before the programmes in either the theatre or music room were concluded, dancing was going on in the big gym., the Stringed Instrument Club orchestra supplying the music. Immediately afterwards the great hall was cleared and here Bill Turner and hi orchestra, composed largely of schoolmen, lead the dancers who were reluctant to leave when the rules of the House said "Quit" at once o'clock.

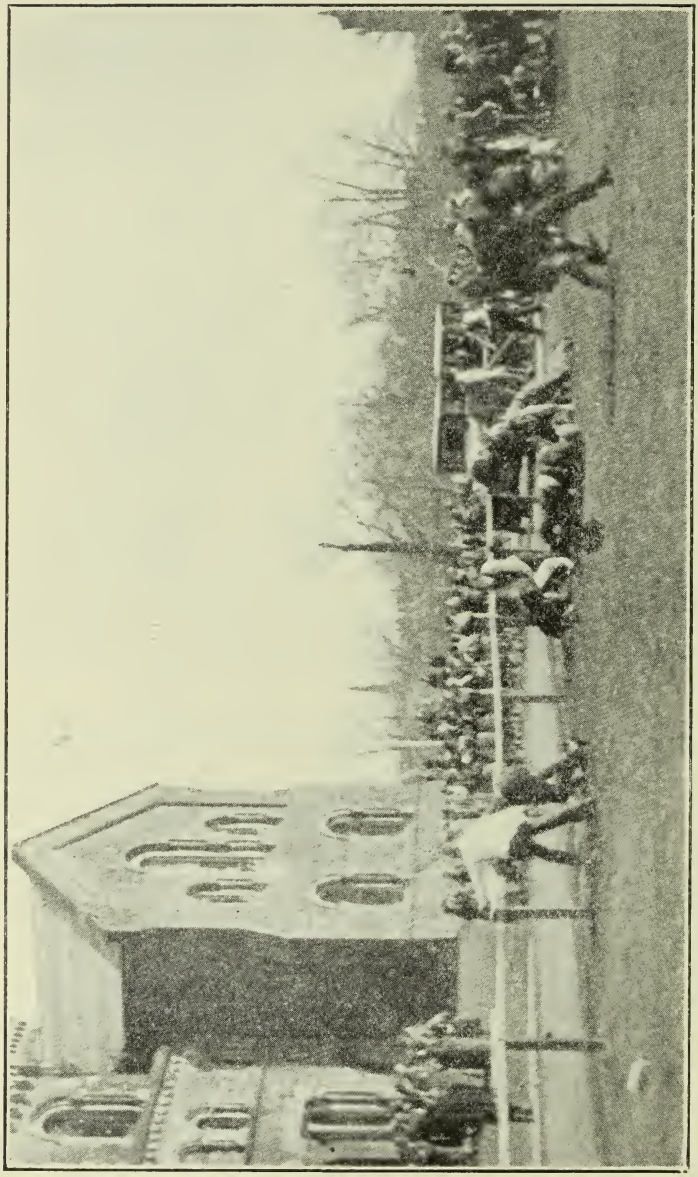
Great credit is due to many men who took an active part in the organization, and owing to the large number (over a hundred) space will permit the personal mention of only a few. Stan Coulter performed heroic feats when he beat back the mob that swarmed about him to secure tickets tor their friends. Eric Taylor successfully fed the gathering in the Great Hall. "Red" Williamson, with his traffic squad, handled the large crowd in a commendable way and at no time during the evening was there congestion in any portion of the building, and to Hugh McIntosh goes the credit of carrying out successfully the publicity required in connection with the event.

W. J. W. REID, Chairman.

THE SCRAP

Wednesday, the 19th, was one of those snappy March days with a bright sun shining and an invigorating breeze playing over the front campus. But this is not all, it was election day at University College!

About once a year the men from that gray old pile of stones, diametrically opposite S.P.S., allow a certain publication called the



Taking Captives in the Recent Scrap

An audience of co-eds may be seen in the background and at the left

"*Once-in-a-While*" to uncover its face for the world to gaze on. Now, this fact we do not deplore, but what did get our bearded quadruped was a reference to the alleged methods of electioneering recently employed by the candidates for office in both the Med and Science campaigns.

It is needless to deny these mis-statements because every embryo engineer and would-be-doctor knows their falsity. In a word, things were ripe for a scrap.

Ten a.m. found the clans gathered discussing methods of procedure to be used on the renegade faculty across the way. Evidently emboldened by the cries of encouragement from the between-lecture crowd stationed at the East Entrance of the Engineering building, the Meds sallied forth across the campus. When they had proceeded three-quarters of the distance, two very strange things occurred; happenings, indeed, which have not been heard of before or since, namely, a sturdy crowd of engineers rushed out and joined forces with Meds and, which is more wonderful to relate, a contingent of Arts actually came out to meet them.

Quickly squelching these men, our troops marched on toward the main entrance of U.C., only to find the gates closed and the doors locked. By this time many Schoolmen had joined the melee and in the next few minutes what looked like the German army before Verdun came around from the side door. With all the impetuous gallantry of cavaliers of the Middle Ages they swooped down on the besiegers, and the battle began.

On and on they fought, rolling in the mud, neither side with much advantage, although the practical faculties were outnumbered. Many heads and faces were given excellent mineralava baths and many clothes were dirtied and torn beyond repair. However, Arts were not without their glory, that is, with regard to the outward sign. Their colors were forced on them so to speak. Briefly, as a Med put it, "We carried 'em down an' painted 'em up."

Shortly before eleven things slackened and School and Meds and Arts formed a snakeline, parading around the campus and Queen's Park with the intention of entering the Parliament Buildings and demanding the repeal of the O.T.A. When upon the steps of that august edifice, they were recalled to the fight by seeing it in progress anew. Then began a battle for place at the entrance to University College. This ended with mostly School men holding the coveted places, as a number of photographs testify. Then the call of the inner man for a well earned luncheon got the better of the contestants' pugnacity, and gradually they dispersed and that great event, the Scrap of 1924, passed into history.

The Fighters at the Main Door of University College

Engineering Society Election Results

President	J. F. Millican
1st Vice-President	W. I. Turner
2nd Vice-President	E. R. Complin
Treasurer	C. K. Lally
Secretary	R. B. Rochester
Curator	H. Vernon

Chairmen of Clubs

Civil Club	A. J. Hill
M. & M. Club	W. R. Chowen
M. & E. Club	C. M. Crossgrove
Chemical Club	A. D. Morton
Debating Club	A. D. Turnbull
Architectural Club	W. H. Steele.

Athletic Association

President	A. W. Jeckell
Vice-President	A. A. Somerville
Sec.-Treasurer	C. A. Morrison
4th Year Representative	V. D. E. Strickland
3rd Year Representative	H. P. Ruggles
2nd Year Representative	G. B. Smith

Year Executives

Fourth Year

President ..... T. E. Bingham
Vice-President ..... Tie betw. Perry & Ratz
Sec.-Treasurer ..... B. V. King

Third Year

President ..... R. E. Smythe
Vice-President ..... R. M. Gooderham
Sec.-Treasurer ..... H. L. Norman

Second Year

President ..... W. H. M. Laughlin
Vice-President ..... W. A. Nichols
Sec.-Treasurer ..... W. E. Weaver

Y.M.C.A. Executive

President ..... W. J. Cameron
Vice-President ..... E. G. Davies
Sec.-Treasurer ..... R. P. Quance

2T4 Permanent Executive

President ..... J. M. Dymond (Acclamation)
Vice-Presidents ..... W. A. Osbourne
W. A. Becker
G. H. Robertson
Sec.-Treasurer ..... T. M. S. Kingston

School Representatives on the Hart House Committees

House ..... A. D. Turnbull
Hall ..... V. B. King
Library ..... K. R. Somerville
Music ..... D. S. Lloyd
Billiard ..... A. E. Beamen

UNIVERSITY of TORONTO
ENGINEERING SOCIETY
EXECUTIVE
1923 ~ 1924
T.B. Smith
1st Year Rep.
G.H. Strang
Engineering Club
Chairman
R.C. Grey
M.E. Club
Chairman
W.H. Campbell
Civil Club
Chairman
H.J. Hugill
E.M. Club
Chairman
T.C. Smith
Vice-Pres.
R.J.W. Field
Senior S.A.C. Rep.
R.M. Laurie
Pres.-Ath. Assn.
G.R. Compton
Chairman
W.B. Cantwell
1st Vice Pres.
W.A. Cobourne
President
C.W. Smart
2nd Vice Pres.
W.N. Becker
4th Year Rep.
R.J. Baker
Chemical Club
Chairman
C.K. Tally
Secy.
J.F. Mulligan
Treas.
P.W. Elson
2nd Year Rep.
E.M. Coleman
Architectural Club
Chairman

THE MECHANICAL AND ELECTRICAL CLUB

The activities of the club throughout the past year has been largely in undertakings which have been completed in a comparatively short time, with one exception. The Club has had the use of a cushion at the Varsity Rink two hours a week, for games between the various years in the departments concerned.

The short, disconnected accounts of the various functions which follow, really cover the history for the year.

The annual trip to Queenston and Chippawa was a complete success as usual. The inspection of the huge power plant, dinner in the building, a visit to the intake at the head of the canal, the Ontario Power Company's intake and plant made up the schedule for the day. As usual the boys provided entertainment for both themselves and the regular passengers on the boat, going over and coming back.

On December 11st, the Annual Smoker was staged in the Lecture Room at Hart House. Mr. Duncan, a consulting engineer from the city, gave a very interesting talk on boilers, touching all types. Moving pictures, songs by Prof. Allcut, John Dymond and the complete "ensemble," capped off by the usual "sandwich and a beer" in the Great Hall all helped to makea very enjoyable evening.

Since January 15th was the date set for the senior hockey team to meet the Hamilton Tigers in their own stamping ground, the Chemical and M. and E. Clubs ran a combined trip to the Ambitious City on that date, to the number of over 250. Through the whole-hearted cooperation of the Hamilton Chamber of Commerce, as represented by their secretary Mr. Healey and his assistant, Mr. MacLean, the whole day was a complete success. The Chamber of Commerce provided free transportation throughout the day, and luncheon at noon, beside making arrangements to see some of the plants which it would have been otherwise impossible for us to visit. The party was split up in groups, visiting the following plants at different times: The Canadian Westinghouse Co., Canadian Porcelain Co., Standard Underground Cable Co., Frost Steel and Wire Co., Imperial Cotton Co., Steel Company of Canada, International Harvester Co., Proctor & Gamble Soap Works, and the Graselli Chemical Co. The luncheon at noon at the Royal Connaught, besides being a most enjoyable meal, enabled the officers of the Chamber of Commerce and the professors to say a few words, between the songs and yells, seated about the round tables. The final and possibly the most pleasing part of the trip was due entirely to "Captain Lou," whose team put the Tigers at the small end of a 4-1 score at the hockey game in the evening.

The last outing was at Oshawa, where about 100 of the two upper years were the guests of the General Motors. The plant of the Pedlar People was visited in the morning, and the General Motors in the afternoon. Between these two very interesting tours the group was tendered

MECHANICAL END ELECTRICAL CLUB EXECUTIVE.

TOP ROW:—

W. A. Nichols (1st Year Rep.),
P. S. White (3rd Year Rep.),
T. E. Bingham (Sec.-Treas.),
F. A. Sampson (2n ' Year Rep.),

BOTTOM ROW:—

V. A. McKillop (Vice-Chairman),
Prof. R. W. Angus (Hon. Chairman),
H. J. Pugsley (Chairman).
C. E. Catto (Vice-Chairman),

a luncheon of no mean proportions by the General Motors, who are certainly to be thanked for their splendid arrangements for the day.

Thus stands the M. and E. Club. It is to be hoped that in the future it may be even more useful in the various phases of the "School" life into which it enters.

HUGH J. PUGSLEY.

THE MINING AND METALLURGICAL CLUB

The opening of the fall term again brought together the seasoned "miners" and "metallurgists," and with them a good quota of unseasoned ones.

The first general meeting of the Club was held in the form of a smoker at Hart House during October. This meeting was more of a "get together one" than those generally convened, the members renewing old friendships and making new acquaintances. Several men related their summer experiences for the benefit and amusement of the Club. The Freshmen introduced themselves individually and, after proving to the satisfaction of the members, thaat they possessed some latent talent, were duly admitted to the Club membership.

In November a dinner was enjoyed, at which, Mr. R. A. Bryce spoke on "the Development of a Prospect." Mr. Bryce gave a very instructive and interesting talk which was illustrated by many personal touches. We endeavoured by changing to this form of a meeting to bring the members of the club and the staff into closer relationship, in this respect Professors Haultain, Guess, Dyer, Ellis and King, who were present, heartily co-operated.

At a second dinner in January, Mr. P. G. Kiely, of Kiely and Smith, stock brokers, spoke on the "Relation of the Stock Exchange to the Mining Industry." Mr. Kiely's address, in addition to giving a few sidelights on the financial end of mining, outlined several sane principles of mining finance and investment, which if followed, would tend to minimize the degree of speculation in this class of stock. This interesting address called forth much discussion.

At a meeting of the Club in February, Professor H. E. T. Haultain gave a short address and showed his latest slow motion pictures on "Ball Paths in Ball Mills." These pictures were very interesting and illustrated the value of research in mining engineering.

The lack of experience in public speaking of the club members was very evident, so, throughout the second term weekly informal discussion groups were instituted. Where many embryorators gave vent to their views on such world wide problems as the O.T.A., Co-Education, Socialism, etc., with no benefit to the subjects but considerable benefit to the speakers.

MINING AND METALLURGICAL CLUB EXECUTIVE, 1923-24

TOP ROW—

K. C. Grogan (I Year Rep.)
L. M. Browne (Chairman Enter. Com.)
A. D. Dickson (II Year Rep.)

BOTTOM ROW—

G. A. Thomson (Vice-Chairman)
K. C. Gray (Chairman)
W. R. Chowen (Sec'y-Treas.)

We desire to express our appreciation to the officers and members of the C.I.M. and M. for the privilege of attending the meetings of the Toronto Branch, also for their invitation to attend the annual general meeting at Toronto in March. At the latter meeting several of the club members had the pleasure of helping on their service committee.

The last meeting of the club was called to allow the candidates for the presidency of the Mining and Metallurgical Club to speak on their respective qualifications.

In conclusion, I wish to take this opportunity of thanking the executive for their co-operation and the club as a whole for its support. In the coming year, W. R. Chowen has been chosen chairman and under his direction we predict a successful year.

K. C. GRAY.

"————seeking riches"

THE CIVIL CLUB

The time draws near when the executive of the Civil Club must hand over their duties and responsibilities to those who are chosen to carry on the work of the club in the "Old Red School House."

The Club's activities for the year commenced on November 20th with a trip to Hamilton. There were enough cars owned by members of the Club to make it possible to go by motor and about 90 members took the trip. The first plant visited was that of the Hamilton Bridge Co. Here, the party were able to see the various operations required in a structural plant, from the time the steel enters the shop until it leaves as a finished product ready for erection. Through Mr. Palmer, chief engineer of the Bridge Company, we were able to visit the Hamilton By-Products Co., under erection by the Solvay Coke Co., and there learn something of the manufacture of illuminating gas, and the by-products ob-

CIVIL CLUB EXECUTIVE.

TOP ROW:—

D. C. Beam (Sec.-Treas.)
J. P. Garwood (I Rep.),
R. E. Smythe (II Rep.),
H. G. Ratz (Vice-Chairman),
C. E. Potter, Jr. (III Rep.).

BOTTOM ROW:—

Prof. C. R. Young (Honorary Chairman)
W. H. Campbell (Chairman),
Prof. R. Gillespie (Hon. Vice-Chairman)
A. R. Chadwick (IV Rep.).

tained. After having lunch, the crowd gathered at the plant of the Steel Company of Canada. Here Prof. Young and the guides were kept busy answering questions, as we viewed the various operations from the blast furnace to the open hearth furnaces, the blooming mill, the rolls and finally to where the finished products were stocked or shipped.

The first technical meeting was held on Tuesday afternoon, Dec. 4th, in C-22, when Mr. Thos. Taylor, bridge engineer of the City of Toronto, delivered an address on "Miscellaneous Problems in Bridge Engineering" and illustrated his remarks with slides of the Bloor St. Viaduct and the new Gerrard St. Bridge.

The Club Smoker was held in Hart House on January 23rd. The evening's entertainment started with an indoor ball game between the 4th and 2nd years, in which the seniors were victorious. The meeting then continued in the East Common Room, where the 2nd year orchestra entertained the crowd. Ted Emerson and "Monty" Laughlin gave several vocal ducts, while Tommy Kingston rendered "Henry VIII." in his own characteristic style. Prof. Gillespie spoke on the meaning of the word "Engineer," and after refreshments, the crowd dispersed.

At the "Schol Stunt Night" on January 29th, the Club provided a miniature bowling alley for the amusement of the crowds, and some record scores were turned in.

The final meeting of the Club was held on the afternoon of Feb. 27th in C-22, when Mr. G. P. Graham, the representative of the "Asphalt Association," spoke on the "Use of Bitumens in Road Construction," illustrating his address with slides and moving pictures.

In conclusion, I wish to thank the Executive for their co-operation and efforts and the members for their support which were prime factors in contributing to the success of the Civil Club during the past session.

WM. H. CAMPBELL,
Chairmaan.

THE INDUSTRIAL CHEMICAL CLUB

The Industrial Chemical Club was forced for this year to curtail it's activities owing to the loss of the grant from the Engineering Society, and the maintaining of a low membership fee, so that every Chemical might belong to his Club.

The first meeting of the Club took place in Hart House when the executive for the year were elected. The following members were

INDUSTRIAL CHEMICAL CLUB EXECUTIVE.

TOP ROW:—

M. R. Feely (Curator),
G. R. Connor (1st Year Rep.),
W. D. Adams (2nd Year Rep.),
A. D. Morton (3rd Year Rep.),
J. A. Dow (4th Year Rep.).

BOTTOM ROW:—

J. M. Jeffrey (Sec.-Treas.),
Prof. J. W. Bain (Hon. President),
H. N. Baker (President),
Prof. E. G. R. Ardagh (Hon. Vice-President)
R. S. Kerr (Vice-President).

elected:—Hon. President, Prof. J. Watson Bain; Hon. Vice-President, Prof. E. T. R. Ardagh; Vice-President, Ralph Kerr; Sec.-Treas., J. M. Jeffrey; 4th Year Rep., J. A. Dow; 3rd Year Rep., A. D. Morton, 2nd Year Rep., W. D. Adams; 1st Year Rep., G. R. Connor; Curator, M. R. Feely.

Previous to the election of the officers, the members attended a meeting of the Society of Chemical Industry, where they heard an exceptionally interesting paper.

The annual Fall Dinner of the Club was held at Hunts. The speaker was Mr. Sherman, of the Illinois Tool Works, who delivered a very interesting talk on the Heat Treatment of High Speed Steel. During the dinner song sheets were passed around, and under the capable leadership of Ralph Kerr, the singing was heard as far south as King St.

The main activity of the year was the combined trip of the M. & E. Club and the Chemical Club to Hamilton, travelling "de luxe" in a special train. The Chemicals visited the plants of the Steel Company of Canada, Grasselle Chemical Company and Proctor and Gambles.

The City of Hamilton outshone themselves in treating the Clubs to a fine luncheon at the Royal Connaught, and providing free transportation around the City. The crowning event of the trip was the victory of Varsity's Hockey Team over Hamilton that evening.

An event appreciated by the 4th Year members was the fine dinner given them at the Society Chemical Industry's meeting as guests of Mr. Scharman of the British American Oil Company.

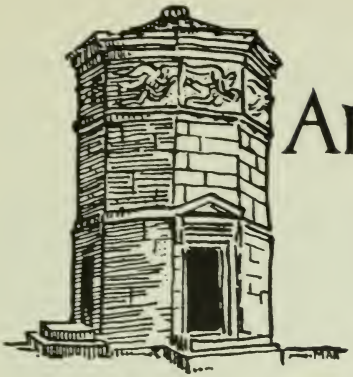
The next event was as guests of the Arts Chemical Club at their smoker in the Chemistry Building. The speaker was a well known schoolman, Mr. Gaby, of the Hydro Electric, who spoke on Hydro Development. The members were afterwards treated to a fine display of eatables, served by the fair sex.

Not to be outdone the Chemicals invited the Arts to be their guests at a smoker held in C 22, when Mr. Scharman, the speaker of the evening, showed some exceptionally fine movies on the Oil Industry. As guests also of the Chemical Club, were twenty members of the staff of the British American Oil Company. Eats were afterwards served in Hart House.

The final event of the year was the Annual Dinner at the Prince George. After the music supplied by Ralph Kerr and "Lily" MacCellan, assisted by the members, an open discussion was held on a variety of subjects.

The meeting was then turned over to Mr. A. D. Morton, the President, for next year.

H. N. Baker,
President.



ARCHITECTURE

The opening of the fall term saw the gang gathered together and the old atelier (highbrow for draughting room) once more began to buzz with conversation and rock with song. Truly, some of the most familiar faces were lacking, having graduated by different routes, but lo, what are these verdant creatures furtively creeping around, trying to appear so wordly wise and efficient? Some eight youths and one maiden signed on for the four year cruise in the unchartered seas of architectural design and verily, they were green.

The boys quickly settled down to good steady work, and the familiar windows of the studio soon began to wink forth their message of industry during the evenings, a beacon to poor, idle, misguided souls of the other departments lost on the waters of the front campus.

Early in the fall, the club in conjunction with Professors Wright and Jeffreys, switched their indoor freehand work to outside sketching, and once a week until cold weather set in the club could be seen up the Don, out at the Humber, or up on the bluffs at Scarboro, industriously making the color fly to good or bad effect, chiefly good, we hope. Then around the camp fire we would gather and many a poor puppy found a glorious end in satisfying the ravenous appetite of the embryo architect.

In spite of imitations the freshmen did not seem to lose their bumptiousness to the required degree, and many a merry minute was spent in introducing them to their lowly, and sometimes dampish, estate.

The first meeting of the club was held at the Five Sisters Tea Rooms on November 27. After worshipping at the shrine of "roast chicken, the club had the pleasure of welcoming Prof. A. W. McConnell back after a year's leave of absence in Europe. Mr. J. M. Lyle, our honorary president, and one of Toronto's foremost architects, also addressed the club, giving us a few thoughts on how to take our training, and on employment after graduation. Prof. McConnell reported himself as being very pleased with the work done so far this year and hoped it would continue. Mr. E. R. Arthur, the new member, of our staff, spoke briefly, and hoped his stay with us would be long and pleasant, a hope heartily reciprocated by every member of the club. The first year then entertained the club to a few enticing samples of their oratory and song. The Architectural Club quartette made its first public appearance and

charmed the listeners with their harmony and humour. After Prof. Wright had said a few words the meeting adjourned.

The next dinner again took place at the "Five Sisters" shortly after Christmas. The speaker of the evening was Mr. Horwood, of the well known firm of architects, Horwood and White. Mr. Horwood gave a very interesting talk on "Inspection and Specifications," illustrated with many experiences in his own career. This talk gave us some insight into the many and various problems that confront the architect and the importance of having plans and specifications, give all necessary information clearly and concisely. The quartette again favoured us with two numbers, and after Mr. Horwood had showed the meeting a copy of his own specifications the club adjourned.

On March 18, the club gathered once more to dinner at Hart House. This meeting was a farewell dinner to Prof. A. W. McConnell, who, after twenty years of faithful service to the department, had resigned to enter the business world in England. After a toast to Prof. McConnell had been drunk a small presentation from the members of the club was made. Prof. McConnell replied, saying how hard it was to sever connections with a work one loved and had devoted his life to, and hoped the department would continue to thrive as it had from the time he had joined the staff when it was a mere infant, up to the present time when it is a thriving and healthy youth. Prof. McConnell wished everyone the best of success and happiness, and extended a hearty invitation to the members to visit him when in England. Prof. McConnell leaves with best wishes for health, happiness, and success in the future, mixed with very genuine sorrow at his departure from the University. Prof. Madill told us of his visit to Europe during the winter and gave us his impressions of the various schools of architecture in England, France and Italy. The meeting then adjourned.

At the time of writing the club looks forward to two more functions. On the evening of April 17th, the club hopes to entertain itself and friends to what we hope will be the first Annual Architectural Club Dance.

From April 9th to 13th the Sketch Room, Hart House, will again be the scene of the Annual Exhibition of the work of the club. Much good work has been done this year, and we hope the exhibition will show the profession in Toronto that good work can be produced from the Dept. of Architecture.

In closing the writer wishes to thank each and every member of the club for their loyal and enthusiastic support, and particularly the following exxecutive, which at all times has been most willing and anxious to work for the benefit of the club:—Honorary President, Mr. J. M. Lyle; Vice-President, W. C. Cooper; Treasurer, J. Ryrie; Secretary, H. Mc Laughlin; Graduate Rep., Mr. H. H. Madill; III Year Rep., W. L. Fawcett; II Year Rep., C. J. Carroll.

To the incoming president, Mr. W. H. Steele, and his executive, we wish every success, and hope that he may enjoy the same enthusiastic support this year's executive has encountered, and that he may go on to make the Architectural Club ever a greater and greater success.

E. M. COLEMAN,
President, Architectural Club.

U. OF T.
ARCHITECTURAL
CLUB EXECUTIVE.

TOP ROW:—

C. G. Carroll
(I Year Rep.),
W. Fawcett
(III Year Rep.).

BOTTOM ROW:—

W. C. Cooper
(Vice-Chairman),
E. M. Coleman
(Chairman),
J. Ryrie
Treasurer).

ABSENT:—

H. H. Madhill
(Graduate Rep.),
R. A. Fisher
(II Year Rep.),
H. McLaughlin
(Secretary).

THE SCHOOL DEBATING CLUB

The opening meeting of the Debating Club was held in Hart House on Oct. 22nd. The Club was addressed by Mr. Robert Bryce and Mr. J. P. McGregor on the subject of "Public Speaking for Engineers." Both speakers emphasized the fact that the engineer who hopes to rise to the top of his profession must be able to think and speak clearly in public. Mr. Bryce pointed out that the time to learn is during college days. Officers for the year were elected and plans for the winter were outlined. It was felt that the present system of inter-year debates while benefit ng a few, was not wide enough in its scope. The primary object of the Debating Club is to afford all school men an opportunity of learning to speak in public. Consequently, after consultation with various members of the faculty, the chairman placed before the Club a new plan whereby in place of the inter-year debates a series of weekly meetings would be held from 5 to 6.30 in Hart House, at which one member would read a paper, upon which discussion wcuild proceed by turn round the group of members present. It was intended that these meetings should be more or less informal in character to encourage the more timid members to voice their opinions.

This plan was approved by the members, and during the winter twelve such meetings were held. The subjects discussed were of a most varied character, ranging through such topics as "A Comparison of the United States and the British Constitution." "The Red Element in Canada." "The United States Participation in European Affairs," etc., etc.

Considerable interest was shown in these meetings, and the results shown have been very gratifying since the improvement in the style and manner of the regular attendants, has been most marked, emphasizing the truth that "practice makes perfect."

The Annual Oratorical Contest was held on March 4th in Hart House, and here it was that the benefit of the winter's work was most clearly seen, as the order of the speaking was very high.

In addition to the Trophy Cup three prizes of books, the choice of the winners, were donated for the purpose of this contest.

In all, 17 competitors took part, and the cup and first prize were finally awarded to P. H. Take 2T4, the second prize going to E. G. Davies, and the third to H. Millar. The judges on this occasion were Prof. E. A. Allcut and Mr. G. J. Malcolm.

At the election held on March 7th, Mr. Doug. Turnbull was elected chairman for the coming year. It is hoped that the success of the present scheme will warrant it being continued on a perhaps more elaborate scale.
Mr. Turnbull has best wishes for the Club's success in 1924-5

GEOFFRAY H. ROWAT.
Chairman.

FACULTY OF APPLIED SCIENCE DEBATING CLUB EXECUTIVES, 1923-24.

TOP ROW:—

S. L. Grenzebach (Vice-President).
A. D. Turnbull (III Year Rep.).
H. Vernon (I Year Rep.).
J. H. Ings (Sec.-Treas.).
E. T. W. Bailey (II Year Rep.).

BOTTOM ROW:—

P. H. Take (IV Year Rep.).
Prof. A. E. Allcut (Hon. President).
G. H. Rowat (President).

SCHOOL S.C.A.

About a year ago there was much discussion on the advisability of School together with the three other Faculties continuing their work under the Y.M.C.A., which for the past two years has been connected with the Student Christian Movement of Canada. It was thought that by forming a separate association comprised of all the Faculties and Colleges in the University that better co-operation would be obtained.

This association was finally formed and was given the name of the Students' Christian Association, which is affiliated with the Student Christian Movement of Canada. The Association is made up of a unit from each Faculty or College in the University.

As in previous years, a reception for the Frosh was held at the beginning of the second term, at which they not only had the opportunity of becoming better acquainted among themselves, but also of meeting many from the senior years.

Spencer Clark deserves great credit for the very efficient manner in which he has controlled the group known as the International Relationships Committee. Numerous papers were read during the year at the weekly meetings, after which general discussion took place. Every few weeks outside speakers were procured, who spoke on the subjects taken up by the group or in which they were deeply interested. Everyone is agreed that this group is an excellent thing and is of great benefit to those who take part.

School sent four representatives this year to the Student Volunteer Convention at Indianapolis These representatives have felt that it has been of great benefit to them, and they hope that they have been able to give out something of what they received while there. The essence of the matter is that no matter which branch is followed, Humanity Engineering should be the dominant factor.

Numerous study and discussion groups have been formed in the University which are open to all Faculties. These have been very successful both from point of attendance and from benefit received. Some of them have been the direct result of the Convention at Indianapolis, and as such have done much to express the student opinion as seen there.

Mr. Ferris has been carrying on two study groups, one for First year men and the other for Second year men. These have met with marked success.

Mr. P. C. Davidson deserves great credit for his work in connection with the Sunday evening Sing-Song in Hart House. It was through his initiative that this was commenced and given a firm footing.

J. BEATTIE.
President.

S.P.S. S.C.A.
EXECUTIVE.

TOP ROW:—
T. R. Emerson
(Publicity).
L. C. Jackson
(Study Groups).
H. S. Clark
(International
Relations).

BOTTOM ROW:—

J. Beattie
(President).
Prof. R. W. Angus
(Hon. President).
H. Papst
(Vice-President).

2T3 SINCE GRADUATION

The graduating class of the year '23 Faculty of Applied Science and Engineering—the largest class in the history of the Faculty, left the old Red School House in a blaze of glory and good fellowship that has not been equalled by any other year of the faculty in the University. April 20, 1923, will live forever in the memory of the "Gang" as a fitting ending to our short years of irresponsible good times, of "skipped" labs. and lectures—and frantic plugging at the end of each year. Every event in that last year will be remembered by the part played by 2T3—from the Registration day to the Last night party." Outstanding, of course, were the "Scrap," Nomination Day and Election Night, and the last big party. The boys still talk with glee—of the nomination speech by Tony Reid and the glories of the last day—from the ball game to the "Smoker" From that evening on the First of May when Sir Robert Falconer bequeathed us with all the benefits tributary to the degree of Bachelor of Applied Science, the year has stuck together with all the old spirit that was evidenced throughout the four years of school.

Every month—on the first Wednesday thereof, the men of the various branches, Toronto, Montreal and Western Ontario, gather together at their respective headquarters to partake of a sumptuous repast—to talk of old times—and to think of the "other fellow"—wherever he may be.—And they are surely a scattered crowd—from Vancouver to Halifax, and from Hudson Bay to Peru, to say nothing of the visitors in the old lands varying from the idle sightseer to the studicus representative in the learned halls of Cambridge University. In Toronto the spirit is particularly in evidence. Besides the dinners a regularly monthly dance was held at the Island throughout the summer, and two most successful Re-union Dances have been held since. Special mention must be made of the one held last Fall on the evening of the day when one hundred Toike-Oiking School men Ripperty Rappertied to their hearts content in the midst of the Queens Rooters at the big game.

One secret of the success of the executive in keeping in touch with the year is due to publishing a year book which has the name, business and home address of every man—and the other is the fact that the year as a unit realized future conditions and showed its excellent foresight by electing unanimously such a president as wins—Tony Reid, One never thinks of 2T3 without thinking of Tony—more power to him.

A very excellent suggestion has been accepted by the Toronto branch —and it is worthy of mention since it will be of interest to the future years graduating, and it is this.

Realizing the lack of opportunity available to the average School man to get a training in public speaking, the Class of 2T3 will have one of its members address the gathering at each of the monthly dinners from now on.

This has been strongly approved by 2T3 and could well be considered by the coming years at School.

We find at the end of the year that many changes have taken place in our ranks. One must pause to think of our two unfortunate members who lost their lives since that day we last met! Arthur Lebeau—(Chemical) who was drowned in Lake Erie early in the summer—and "Verne Stokes"—so well known to all the year—who died of malaria while a member of the ill-fated diamond expedition to British Guiana. Many others have been almost lost to us through the bonds of Matrimony—and since there are many indeed, we must draw the line at one 'Honourable Mention"—Pat Lyle, who slyly "Put it over" on the boys last spring. And now after these short months the class of 2T4 comes out—and 2T3 passes into the more ancient ranks of the graduates of the old School and in closing—the Year wishes to extend to the closely allied class of 2T4 among whose ranks are men of all depts. of 2T3—the very sincerest wishes for all success—and the warmest welcome to all or any of our social and accidental? gatherings—and at the same time wishes to take this opportunity of again expressing our appreciation of the work that the Staff did for us in our four years at School—and extending to them also our heartiest wishes.

H. E. WINGFIELD, Vice-President.

THE ENGINEERING INSTITUTE OF CANADA

This is not written with the intention of reminding the E. I. C. members in school of the instructive addresses and introduction to the profession that the institute's meetings have afforded them during the last year. It is for the first year man who is trying to get his bearings and the second year man with his three dollar fee ready to send in.

The Engineering Institute is the Dominion-wide fraternity of all engineers. There are twenty-four branches strung in a line from Sydney, Cape Breton, to Victoria, which form the meeting places of the five thousand four hundred and thirty-two members of the Institute. Thus the member, student or affiliate, can feel at home anywhere in Canada.

The Institute is more than a club; it is a real force in the Dominion of high ideals. "To facilitate the acquirement and interchange of professional knowledge among its members—to promote their professional interests, to encourage original research, to develop and maintain high standards in the engineering profession and to enhance the usefulness of the profession to the public."

The members by means of papers keep each field of engineering in touch with the others, at the same time instruct and boost in their own field. The Institute is at all times on the alert to promote the interests

of the profession, financially and otherwise. The annual report, for nineteen twenty-three illustrates the varied nature of the Institute's interests. There is the report of the committee on a code of ethics; on remuneration of engineers; the reports of the members as representatives in the Canadian Engineering Standards Association who are considering moveable bridges, screw threads, reinforced concrete, watthour meters, wire strand, gasoline and lubricating oils, and cast iron. The interests of the public are not forgotten, for a main committee and one in each branch are making a survey of the fuel situation in Canada with a view to recommending measures for the relief of the distressing conditions which have arisen this last few years. It is obvious that the E. I. C. is a live organization, and one worth supporting.

The subjects of the papers and discussions held at the meetings are of highly varied nature. A survey of the report for nineteen twenty-three shows that twenty-two per cent. of the papers were of electrical nature, twenty-nine per cent. mechanical, twenty-six civil and twenty-three per cent. general.

The Toronto branch has always shown particular interest in the student. This year under the chairmanship of Prof. C. R. Young, the students had the opportunity of being hosts in Hart House to the Toronto Branch. This occasion was carried off very successfully by Prof. T. R. Loudon, who was rather alarmed to find one hundred and forty on hand for coffee and doughnuts. Later in the year prizes were awarded by the Branch for the best three student papers. The successful entrants being in order: G. H. Rowat, who spoke on "The Photo-Elastic Method of Stress Determination; L. H. Burpee, who discussed "Power Development on the St. Maurice River," and H. A. McIntosh, who dealt with Causes of Lack of balancing in Automobile Engines."

The prizes which were donated by the Branch were $25; $15 and $10.

The student members welfare at school is safe in the hands of Prof T. R. Loudon, who is chairman of the branch committee of the Institute on Student's Activities, which includes two other school men, R. W. Downie, and A. M. Reid. This committee has laid down the policy that the E. I. C. should not in any way interfere with the Engineering Society, which is primarily the student's society.

It is obvious that it remains with you, gentlemen, to appreciate the opportunity. You are the future E. I. C., make it worth-while by interesting yourself in it now!

S. HARDCASTLE,
S. E. I. C.

2T4

The fourth and last undergraduate year history of 2T4 is to be written.It may sound to some extent quite similar to others that have been written, but let us hope that it contains for every man graduating, memories which are forever separated from any other class history ever written.

The first event of the fall term was the informal joint dance with the third year, at the Palais Royale, Sunnyside. The joint Dance idea, a new one, worked splendidly. The difficult traffic question was solved by the complete chartering of the Yellow Cab Taxi Company.

The balance of the fall term was given up to Thesis writing, coupled with an intense interest shown in the Mulock Cup series. The Senior School Rugby Team went to the finals, due partly, no doubt, to the interest taken by our men as players and supporters.

These over; an invitation was accepted from the fourth year U.C. Girls to a dance at the Women's Union on January 8th. The party was exceptionally well arranged by Miss Weir, and her competent executive, and a large percentage of the year enjoyed a splendid evening.

The year smoker was held at Hart House the following evening. Entertainers were present from down town, and impromptu selections and stories made a perfect stag party.

One week after "School Night" at Hart House, namely Feb. 6th, came the Graduation Dance. The good old hostelly King Edward was taken over for the occasion, and the dancers in the year turned out in force to celebrate a fitting finale of our social events. Over twenty 2T3 men equipped with monocles inserted their usual pep, and added materially to the evening's success. Tommy Kingston's rendition of King Henry the Eighth was much appreciated during the supper.

The executive activities were not wholly along social lines.. The Engineering Society, with the fourth year, co-operated with tthe staff in attempting to found a permanent employment department. The success of the work this year is assured, and we must put forth every effort if we believe it is a necessity for future classes.

Realizing that we cannot mention all who have been active throughout the year we would like to make a few acknowledgements for help from men not on the executive. Roy Chown has made a good job of the Torontonensis work, and Stan Coulter and Jack Dymond have been always ready with help and advice. Ted Emerson has done numberless signs. We are proud also of the administration of the Engineering Society under Bill Osbourne.

Shining spots in the years activities have been Holly Keefler's work on the swimming team, Glad Thompson's on the Hockey Team. Wally Baxter's and Ray Sirrs' on the rowing crew, Grenzebach's fencing, and Russell's and Kingsmill's rugger, and also Campbell's Soccer. Other T holders are Harry Firth, Lacrosse, A., Chadwick and M. Wolsey Gymnasium and Steve Greey, Tennis.

IV YEAR
EXECUTIVE, S.P.S.

TOP ROW:—
Hugh Allen McIntosh (Publicity),
J. A. Dow (Chemical Rep.),
W. C. Cooper (Architectural Rep.),
Charles E. Catto (Mech. Rep.),
W. J. W. Reid (S.A.C. Rep.),
Bruce C. Matson (Ath. Rep.),
K. G. Gray (Mining Rep.).

BOTTOM ROW:—

V. A. McKillop (Electrical Rep.),
A. R. Colman (Sec.-Treas.),
Dean Mitchell (Hon. President),
W. A. Becker (President),
Gordon H. Robertson (Vice-President),
A. R. Chadwick (Civil Rep

A resume of the class formation might be interesting. We entered 180 strong, and have lost many by the wayside. We go out 165 in number, of which two-thirds are originals, and one-third are 2T3 originals. Our class is strongly linked with 2T3, and we hope to continue the cordial relations so far maintained. 2T3 men repeating have fused with our organizations, and served on our executives in a manner entirely typical of their whole class history.

Our feelings as we leave School, are, of course, a mixture of anticipation and regret. There are very few of our fellows who have not worked and been interested with us on matters apart from academic work. For this reason we feel that the education of the members of our year has been as complete as possible in these surroundings, and we can look into the future with confidence inspired by a good beginning.

A feeling of loyalty and appreciation of the associations begun here, will, no doubt, be shown in the relations with the permanent executive under the competent leadership of Jack Dymond, no doubt to be assisted a little later by Jack Junior. Tommy Kingston, as Secretary-Treasurer, will write to us at least once a week.

W. A. BECKER.

2T4 GRADUATING DANCE

The Graduating year's parting gesture to the social world was also their most successful and complete function. The class acquiired, during their four years stay, a notable reputation for putting on the best in the way of dances, and the Grad. Dance showed to all posterity how it should be done.

The best ballroom in Canada—The Crystal Room at the King Eddy, and the most famous orchestra obtainable—Jardine's, were secured. The ballroom was decorated simply, with the School and Class banners featured on the balcony, and 2T4's usual, or unusual, originality in the way of novelties, was given full opportunity to function.

Discarding all the time honoured methods of chosing the lucky couple, this important part of the program was carried out with the aid of a table full of mysterious chemicals, which were combined to give a brilliant colour, and the lady whose dress most nearly matched the colour produced, was chosen by one of the patronesses as the lucky one.

The Snow Dance was a huge success. A large and life-like Snowman burst open to reveal Miss Helen Codd, dressed as the Spirit of Winter, and the dancer then gave an excellent toe dance interpretation of her role.

Supper in the Pompeian Rom was listed on menus with an Engineering flavour—blue prints splendidly printed and decorated. The courses listed, when they arrived, were found to be as good as they looked. The class songster was detected eating peacefully, and was immediately raised into prominence and politely requested to sing his famous song

"Hennery the Eigth," which he did amid loud acclamations. The intermission was marked by a carnival spirit, which was not seen to such an extent in the Ballroom.

Perhaps the realization that the dance was the last of a long series of happy affairs, and marked the passing of the year from the good old "School," brought a little tinge of serioousness and a great deal of regret with it, but it was a huge success anyhow, and in years to come the men of the year may have forgotten when they entered and what class they finished with, but they can always say "Why, I remember the 2T4 Graduating Dance.—.

After the alloted span of holidays, 2T5 again assembled to indulge in the third spasm at School. As seems to be the custom, we were plus and minus. Minus some who somehow or other did not manage to make the grade, and plus some who must have found School life so enjoyaable as to be unable to stand the prospect of graduating so soon.

To renovate our class spirit we easily joined together in the good old institution sometimes known as "Combustion Lab." To vary the usual run of these affairs we had as our slogan, "see 2T5 first!" and put on a strictly home talent show. Bill Turner and Doug. Flett covered the worries at a surprising rate and their offerings were backed up by instrumental numbers from others members. Community singing and eats rounded out one of the best gatherings 2T5 ever enjoyed.

Then came the one "big" event. In conjunction with the graduating year, we staged a very successful hop at the Palais Royale. Yellow Cabs, Rolls Royce, and jits of every description gathered the youth and beauty, and for hours they danced to the music dispensed by Jardine and his melody men. Joy whistles bedecked with school colours, were provided to enable those, so wishing, to assist the orchestra. It must be admitted that the result was nearer noise than melody. Anyone in 2T5 will tell you that it was one of the best dances they ever attended, and all due credit must be awarded the joint committee of 2T4 and 2T5, who gave so unselfishly of their time and labour, to make the evening a success.

From the Palais Royale to Hart House Gym. is a long jump. Nevertheless it must be made to recount our next success. Many the brave man fell before the stalwarts of 2T5, as we battled our way to the top in the School Assault. Both in boxing and wrestling, members of our year won for themselves the honour of representing School in the Inter-faculty Assault. So another feather was added to the already long line of 2T5 athletic victories.

Christmas, which is always connected with the pleasures (?) of exams, and home-going, rolled around. Then the second smoker. The Gull Lake Civils fought hard to win a basketball match from the E. & M's, but after playing overtime the E. & M.'s carried off the honour of a one run lead. An inovation was the lantern slides of popular songs, supervised by Digby Wyatt, and so we were almost able to drown out Bill's Orchestra. Smokes and eats were plentiful, and what more is needed to make a smoker?

On January 29th the School again went over the top with School night. 2T5 played a prominent part with their ministrel show. Ernie Pearin and Ross Dickenson were the stars of an Act openly said to be the best of the night; by members of 2T5 anyway.

From School night to elections, seemed no time, and March 4th found 2T5 assembled in Hart House to hear the candidates talk. Fiery speeches were the order of the night, and before long the various offices were crowded with hopeful candidates. Then campaigning set in, and with it the free smokes and blotters. Not even the wisest could foretell the results of the elections.

The success of the year's activities was only made possible by the keen interest, the year as a whole took in these affairs. The executive is truly grateful for the support accorded it throughout the session.

The ruins of office will pass on to better hands, and who can deny the best of graduating years, with Tom Bingham at the helm. Backing him up we have two good vice-presidents in Spence Perry and Herb Ratz, (even the year couldn't choose between them). In addition we are assured by sound financing by the Sec.-Treas., Verne King. Taking all these things into consideration we predict a "real" year.

HERBERT C. SMITH,
President.

2T6

Though somewhat reduced by the ravages of the "spring engagement" the year, to the number of 127 assembled once more on October the first. New members of the year were welcomed, executive officers got busy, and a united year turned to the annual business of introducing "The Frosh" to the world of school men.

Green ties appeared, adorning the campus and moist heads. The first year lecture rooms impressed on thefrosh the necessity for the proper display of these verdant appendages. The initiations came off three weeks later and were a distinct credit to all concerned in that nothing occurred which was not directly useful in bringing both years together with good old school spirit.

The arrangements at the old gym were under the supervision of Vice-President Nugent, who ran all candidates through in the space of an hour and a half. After a thorough clean up, a snake parade wound its way

from Hart House to the second year draughting room, where eats, drinks and good fellowship were dispensed to all. The closing chapter of the initiation was the Soph-Frosh banquet, where the second year was well and royally entertained by the first.

Later in the fall a most successful smoker was held, at which almost the whole year disported itself. Here Director John Fox introduced the 7 piece 2T6 orchestra to a delighted year, and our thanks go to this organization for its assistance at this and other functions.

The time now seemed ripe for a dance and plans were gotten under way for the "Junior School Dance." On January 11th, it passed off a blaze of glory. Jenkins saw a joyous crowd of first and second year men demonstrate, with the assistance of their partners, how thoroughly the coming engineers can enjoy such an occasion. Mrs. Mitchell, Mrs. Loudon and Mrs. Bennett patronized the dance and by their presence added charm to the whole evening.

Great credit must go to the executive for its work during the whole year, but special mention must be made of the original way in which they organized a big smoker during February.

In athletics the year bows to none. We have in our midst a number of T holders. Morrison, track; Thompson, rowing; Gooderham and Charolski, gym team, and many others who are looking toward the same reward. Representatives of the O.R.F.U., intermediate and junior rugby teams, also brought credit to the year.

In interfaculty sports a prominent part was taken by year athletes. Jr. School rugby team just missed the semi-finals by a minute's play and the basketball team after winning its group lost out in an overtime game in the semi-finals of the Lipton cup. In hockey and baseball the teams fought hard but though they won a majority of their games, failed to win a group. In track we had many representatives, the chief of whom was Charlie Morrison, the intercollegiate quarter-mile champion.

Undoubtedly the year will go forward to even greater successes and next year, under the capable administration of Pres.-Elect R. Smythe and his exxecutive, seems an auspicuous time.

D. DOW, President.

2T7

Last fall 2T7 started its existence with a memberbship of 125, including two of the weaker sex, and in spite of the strenuous months through which we have passed no casualties have been reported.

We certainly were a green lot last fall, but perhaps no different to any of the thousands of other Freshmen who have gone before us. It did not take us long to adapt ourselves to circumstances—after a few

kindly hints from beloved Sophs. We remembered that ties were to be worn outsides of vests and that hats were to be removed in the buildings. We did everything we were told to do and sometimes a lot more.

The formal reception which the Sophs tendered us will long be cherished in our memories. Oh! those kind-hearted Sophs! How they welcomed us with wide-open arms, inviting us to accept their hospitality in the old gym; and such hospitality—everything from tar to soft soap, not forgetting the "staves." But we "grinned and bore it," at least 123 of us did, as owing to some unforeseen circumstance our two freshettes were not with us. After the reception we all piled down to Convocation Hall, where we were again treated by our hosts to an apple and a glass of cider. Here we learned that the chief indoor sport of School was chariot racing.

In order to repay the Sophs for the kindly interest they had taken in us, we staged the Soph-Frosh Banquet at the Carls-Rite Hotel last November in their honor. Sir Robert Falconer, Dean Mitchell and members of the staff were present as our guests. A good musical program, several boxing bouts, speeches, songs and stories, all went to make a most successful evening. The other social functions in which our Year was interested were the School dinner n Hart House, the Junior School dance, and School "at-home." First Year had a representative on eeach of the committees, and members of the Year turned out in large numbers to support them.

True to School traditions, 2T7 has brought with it many promising athletes. The splendid success which 2T7 has achieved in the past year's athletic activities was due not only to the interest taken by the athletes themselves, but also to that taken by he whole year. The first success resulted from the University Freshmen track meet, in which the 2T7 team came second in the total number of points, being only 3 behind the winners.

The fellows combined again in an effort to win the indoor inter-year track meet, in which they won out by a one point margin. 2T7 was well represented on all the junior inter-faculty teams. An extremely creditable showing was made at the Inter-year Assault-at-Arms. It can also be said that 2T7 was represented on the following teams:—Hockey, Rugby, Basketball, Swimming, Gymnastics and Rifle.

In conclusion it may be said that the Freshman Class has done and will continue to do everything in its power to uphold and maintain the grand old traditions of School and Varsity.

W. M. LAUGHLIN.

School Athletics, 1923-24

THE SCHOOL ATHLETIC ASSOCIATION

With the formal presentation of School colours by Dean Mitchell the Athletic Association closed its activities for another year. Success is often calculated by the number of victories scored. In athletics, however this is not the true guage of success. School this year had a successful year despite the fact that only 4 cups found their way to the little Red School House. Two teams finished well up in their respective races. Last fall School opened with a registration of nearly two hundred less than the preceding year. This was due largely to the graduation of the large year of 2T3 a large number of whom took a leading part in Athletics. Despite this admittable loss the team managers rounded out their new material and where unsuccessful as winners made School' strength felt in every branch of the game.

However another year might as well see all the cups at school as only 4. With this end in view much of the usual advice could be given. However this short story is not meant as prophecies and advice of the future but rather memoires and criticism of the past. One thing that stands out from this last statement is the fact that faculty clubs fully organized seem to have a larger measure of success. To this statement I would advise the formation of clubs in school for all branches of athletics not so organized. By this means managers and coaches could be appointed by the clubs in advance and especially in the case of managers, who in most cases, unfortunately are the coaches also, men could be picked who are keenly interested in their respective sports.

Let me say here that to the managers go a great deal of the credit for the success of the various teams.

More inter year competition would be a splendid thing and to foster this idea a cup was donated this year for the winning year in a School Assault-At-Arms. This year 2T5 carried off first honours. By inter-year contests many men are brought out who would not venture into inter-faculty contests.

For some years these clubs have been established in School—the Track Club, the Social Club and the B. W. and F. Club. To these have been added just recently the S.P.S. Rowing Club, from which organization great accomplishments are looked for in the first inter-faculty regatta next fall. This is a branch of sport that has always been popular with School men. For a number of years the Varsity Senior Crew has found a strong representation from School. And yet, when we stop to consider it, why not when the University rowing coach, one of the best in the game, is a popular School graduate and professor.

On the Varsity teams School was fairly well represented and if, in any branch such as hockey, the quantity was lacking, this was made up in the quality. Although Varsity did not win the senior and junior Canadian hockey honours, it was no fault of the goal keepers.

S.P.S. ATHLETIC ASSOCIATION EXECUTIVE, 1923-24.

TOP ROW:—

S. W. Perry (III Year Rep.),
W. L. Thompson (II Year Rep.),
B. C. Matson (IV Year Rep.),
A. A. Somerville (I Year Rep.).

BOTTOM ROW:—

F. J. Milne (Sec.-Treas.),
Prof. T. R. Loudon (Hon. President),
R. M. Laurie (President),
C. A. Morrison (Vice-President).

Glad Thompson and Ross Dickinson are two of the best that Varsity have seen for a long time, and the School wish Ross Dickinson every success in filling the position on the senior team next year, left open by Glad Thompson on graduating.

The S.P.S. and Varsity gym team, which was practically one and the same, carried off all honours.

School once again has shown its superiority in both indoor and outdoor track work.

The B. W. & T. Club did fine work and developed a lot of new material, while the rugby and soccer teams were the two teams that went down to hard defeats in their final games.

Hockey, baseball and basketball all made good showings, and the polo team which finished second in the standing, although beaten by the winners, had the honour of being the only team to score against Arts, who carried off the Eckardt Cup.

In the face of these facts no one can deny the success of the past year, nor the honour School men have brought to their faculty and the executive wish to extend the praises of School to all the men who took part in the various branches of athletics, and also to thank the managers and coaches for there share of bringing success to School.

R. M. Laurie, Pres. S.P.S. A.A.

RUGBY

The season of 1923 was not a very successful one for Varsity rugby.

In the senior series, Varsity lost both games with Queens, but won from McGill at Montreal and lost to them here.

The O.R.F.U. team, under the leadership of Captain Sorby, of School, made a creditable showing in their league and made Hamilton Rowing Club show all they had to defeat them.

The Intermediates, unfortunately, did not get out of their group, but the Juniors got into the finals and only lost to Loyola College after a hard battle.

This year, for the first time in many, the School was not represented on the regular Varsity senior team. Three years ago School had eight men on the team and our Mulock Cup teams were nowhere. Last year with two men and this year with none on the team, our Interfaculty teams were champions and runners-up. It would seem the School rugby players are forgetting the University in favour of the Faculty. This is not as it should be, and it behooves every would-be Joe Breen to get out next year and try hard to make one of the Varsity teams.

Junior School started out poorly this year, but near the end of their schedule they were going great guns and were only nosed out of their group title by Junior Arts. The majority of their players were first year men and Junior School should do well next year.

SENIOR SCHOOL RUGBY TEAM.

MULOCK CUP FINALISTS.

TOP ROW:—

W. D. Lappin,
G. F. Dean,
R. Dickinson,
K. F. Parker,
C. Woodburn,
E. M. Little,
L. N. Hunter,
F. J. Wallis,
W. G. Lloyd.

MIDDLE ROW:—

K. V. Heyland (Manager),
J. A. Dow
J. F. Millican,
C. S. Sneyd,
R. M. Norman,
V. B. King,
T. E. Bingham,
R. M. Laurie (Pres., S.P.S.A.A.).

FRONT ROW:—

G. W. Beecroft,
C. T. Sharpe,
G. H. Robertson, (Captain),
G. B. Sullivan,
H. M. S. Pentelow,
E. F. Connolly.

Big things were expected from the Seniors this year, and captained by Gord. Robertson, they came through in fine style, only to lose to Victoria in the finals by the close score of 1-7. Lack of good hard practice and condition tells the tale.

Among the third year men on the team there was some mighty fine material for the Varsity teams, and those fellows should get into good shape next summer and try their hardest for a position on the Varsity squad.

K. V. HEYLAND,
Manager.

HOCKEY, 1923-24

Hockey

During the past season Varsity was represented by strong hockey teams, but were only successful in capturing one title, the senior intercollegiate.

Varsity seniors made a tour of the American universities during the Christmas season and had no difficulty in winning five straight games. In the senior intercollegiate they won five games and lost one, outclassing their rivals from Kingston and Montreal. Playing brilliant hockey in the senior O.H.A. group they qualified to meet Hamilton in the play-off. Varsity decided to stake their chances for the Allan cup on this play off and to give up their right to challenge as intercollegiate champions. Varsity presented a changed line-up for the first game and lost 1-5 and Hamilton increased the lead by winning the next game 4-3.

Varsity intermediates were defeated in their O.H.A. group. In their intercollegiate group they tied with Osgoode Hall and lost the play-off by a one-goal margin in overtime.

Owing to their heavy schedule in the O.H.A., Varsity decided not to contest the junior intercollegiate series. Varsity finished first in the regular schedule of their O.H.A. group and then played off with Aura Lee, the second team for the group honors. After playing two tie games they won the last by one goal. The last three games were played within a week and the team was immediately compelled to play the fast Owen Sound aggregation. Owen Sound won, but Varsity provided them the greatest opposition they had received.

School was represented on the senior team by Glad Thompson and on the junior team by Dickenson, both goalies. Thompson graduates this year and he will certainly be missed. Dickenson was the mainstay of the junior team and is considered to be the peer of junior goalkeepers.

In the interfaculty series, junior school finished second after making a bad start. The following players were on the team: Bentley, Perry, Auld, Sutton, Flintoff, Allen, Wright, Burnside and Sampson (manager).

Senior School tied with Sr. Meds for honours in their group by winning five and losing one game. In the play-off, Meds won and later won the Jennings Cup quite handily. School were without the services

of Hugh McCulloch, their star defence man, in the play-off and this had much to do with their defeat. The following players represented Sr. School: Little, McCulloch, Connolly, Strickland, White, Lillie, Greey, Ryan, Capel and Lee (manager).

A. J. CAPEL,
Capt. Sr| S.P.S.

ASSOCIATION FOOTBALL

Intercollegiate soccer was revived this year on a new basis, with Queens', R.M.C., and Varsity entering the series. Owing to financial considerations it was decided to play sudden death games in Kingston, instead of the usual home and home games. In the first round R.M.C. won from Queens' 3-0 and Varsity then brought home the championship by defeating R.M.C. 6-2.

Arrangements were made with Penn. State College for a game at the Stadium on Nov. 5. The Penn. State team was just completing a tour at the time and had beaten some of the best U.S. intercollegiate teams. The game was played on a muddy field, and with a light rain falling, but despite adverse conditions an excellent brand of soccer was displayed by both teams, and a strenuous game resulted in a 1-1 tie.

With the affiliation of the Canadian Football Association and the A. A. U. of C. it is hoped that next year it will be possible to arrange a series of games between a Varsity team and some of the amateur teams here in Toronto. This will make the formation of a first team independent of the question of an intercollegiate series, and will stimulate interest in the game around the University.

In interfaculty soccer, as usual, School played a prominent part, and helped to keep the game up to the high standard of recent years. Following the precedent established last year, two teams, Junior and Senior, were entered in the series, being placed in different groups.

The Juniors came to grief in the first round, but gained some good experience and showed that all School's chances of winning the cup will not depart with 2T4. The Seniors had better success and won their group after stiff opposition from Dents and Victoria. Meds., who were in the same group at the first of the season, defaulted a game to School and were forced to withdraw from the series. In the semi-finals, Sr. School were allotted the task of subduing Arts, who furnished the surprise of the season by holding them to a one-goal lead on the round.

The first game of the finals was played in Guelph on December 4. Playing on their own ground, O.A.C. was the better team, and gave School's hopes of winning the cup a rude jolt by taking the long end of a 1-4 score. The return game was played on the front campus on Dec. 8, and School showed a reversal of form, defeating the agrarians by 1-0. O.A.C., however, won the round and the cup.

The success attained by the team was largely due to the efforts of our honorary coach, Prof. Allcut, who was present at nearly all practices

SENIOR SCHOOL SOCCER TEAM.

TOP ROW:—/

L. O. Campbell (Manager),
T. Legg,
R. Story,
M. Milne,
F. Perry,
S. L. Grenzebach,
F. Bridge,
Prof. A. E. Allcut (Coach).

BOTTOM ROW:—

M. Meikle,
C. P. Bruels,
G. D. Scott (Captain),
S. T. Franks,
D. Melick,
F. Milne,
Prof. C. H. Wright (Hon. President).

and games, and whose advice and criticisms proved a great help to the players. The effect of his constant coaching was evident in the marked improvement in the playing of the Senior team in the last few games. As a mark of esteem, the teams persented him with a handsome pipe at the close of the season.

A few words to next year's players: You have a first-class executive; give them your full support. Don't quit if you are not chosen to play the first game; you may only need a little extra practice, and you may be certain that your manager and coach are watching for signs of improvement. Remember that it is up to each and every man to do his bit for the honour of School. The Arts Faculty Cup should return to the Engineering Society next year. The best wishes of 2T4 go with you in your efforts to bring it back.

L. D. CAMPBELL,
Manager.

TRACK

As long as most of us can remember, School has been supreme upon the track, but last spring it was felt that it would be better if we had a definite organization. Messrs. Evans and Browne conceived the idea of forming a School Track Club, and aided by Prof. Allcut, they drew up a constitution which was approved by the Engineering Society, and the School Track Club came into being. J. C. Cade was elected President, but did not return last fall.

The officers for the year were as follows:—Honorary President, Prof. E. A. Allcut; Honorary Vice-President, Prof. T. R. Loudon; President, A. D. Turnbull; Vice-President, W. L. Thompson; Secretary-Treasurer, J. F. Millican; 4th Year Rep., M. Meikle; 3rd Year Rep., D. L. Polack; 2nd Year Rep., C. A. Morrison; 1st Year Rep., J. H. Russell.

Owing to the fact that S.P.S. did not start until a week before the interfactulty meet, and the fact that the Faculty would not grant a half-holiday, School did not have an inter-year outdoor meet. Even with this handicap, we came within one point of winning the Freshman Meet, and easily won the Interfaculty meet with 52 points as compared with 36 points for U.C. as second.

School was represented on the Intercollegiate team by Millican, Ruggles, Morrison, Polack, Willard and Thompson.

An inter-year Indoor Meet was held shortly after New Years, and there was a very good turn-out of contestants, especially from the First Year. 2T7 won from 2T5 by one point, with 2T6 third.

In the interfaculty Indoor Meet, School's grand total was 79 points, with U.C. second with 23. The outstanding man in indoor was Perry, who won four events, breaking three records besides competing on the six-man and four-man relay teams.

This year an S.P.S. Track Club jersey was designed, and jerseys were presented to point winners in the Outdoor Interfaculty Meet. The jersey is white with a diagonal stripe of blue and gold.

Next year there is very little time between registration and the Interfaculty Meet, so it will be necessary for everyone who intends to compete to do some training during the summer. There will be a half-holiday for the Inter-year Meet on Monday, October 6th, and the Interfaculty Meet is two days later, Wednesday, October 8th.

There is a new cup for Outdoor Track next year. The Victoria College Athletic Association has put up the "Lanky" Rowell Cup in memory of "Lanky" Rowell, captain of last year's track team, who died during the summer of 1923.

The Toronto Cricket Club Cup, which was formerly the outdoor cup, will now be up for Interfaculty indoor competition. There is a glowing opportunity for bright young athletes in the jumps, hurdles, javelin, discus and shot, so next summer some of you husky boys get out and get some practice, and come back next fall prepared to lift the roof off.

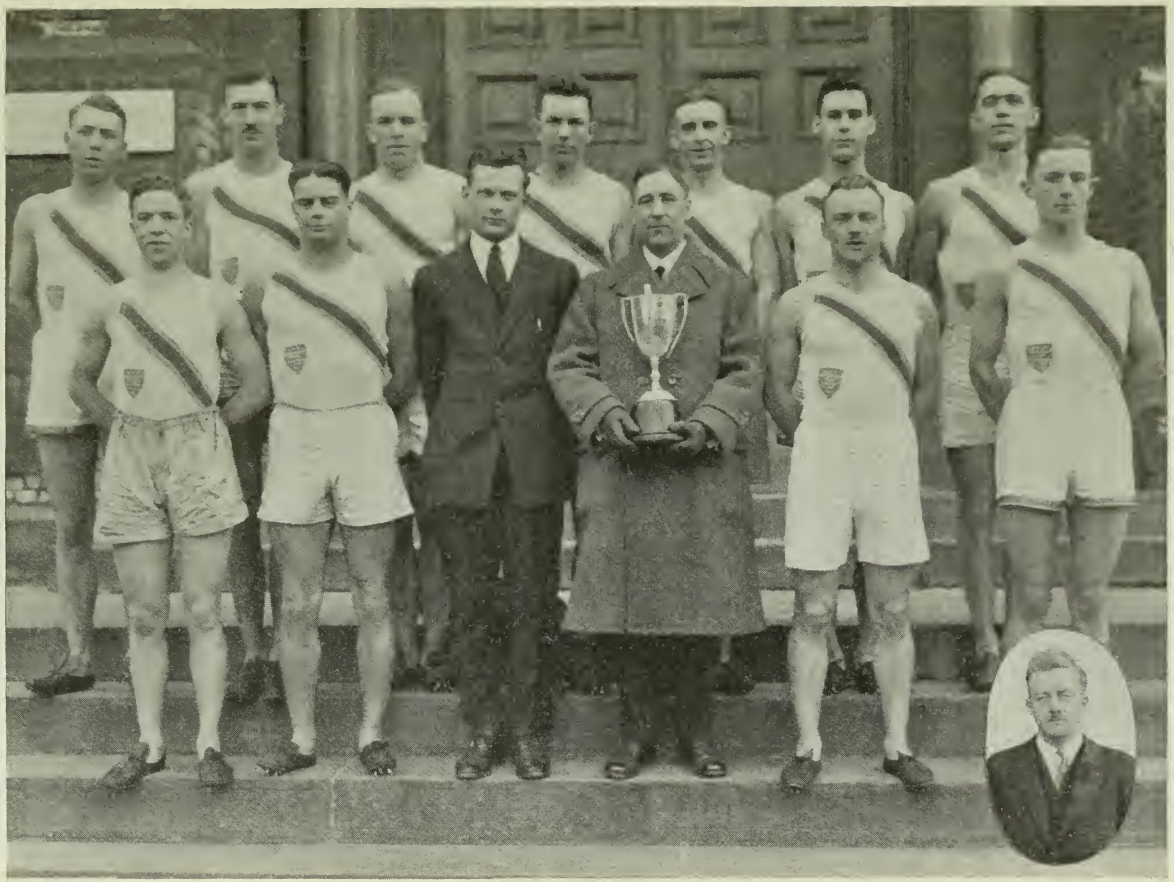
The S's granted for track during the year were:—E. F. Connolly, J. H. Ryan, A. A. Somerville, S. W. Perry, C. A. Pollock, G. B. Smith, E. G. Willard, H. P. Ruggles.

A. D. TURNBULL.

THE BOXING, WRESTLING AND FENCING CLUB

The B. F. & W. Club is now one of the established institutions of School. Organized in the fall of 1922, the club was responsible for the fine showing of School last year. This year it was felt that even greater things might be accomplished. At a meeting held early in the fall, E. B. Hubbard was chosen as President; A. M. Toye, as Manager, and A. A. Somerville as Secretary of the club. H. L. Norman and C. L. Brittain were elected to look after the interests of the 4th and 2nd years respectively.

A stirring inter-year tournament was held on Dec. 5th. Champions and near champions were excluded, and this encouraged those without tournament experience to come in and get their feet wet. As a result the Freshmen, who are inclined to be diffldent about trying their skill, entered in large numbers and made a determined effort to lift the cup. However, 2T5 had the edge in experience and finished up in front of the field, although 2T6 were close on their heels. Lloyd and Stephens won the 125 and 135 lb. boxing without difficulty. Of the Freshmen, Hillier, Ballachey, and Irwin all showed promise. Irwin looks like a good prospect in wrestling. Barr and Soucy of 2T6 may be counted upon to keep School prominent in fencing.



S.P.S. TRACK TEAM; INTERFACULTY CHAMPIONS.

TOP ROW:—

C. A. Morrison,
W. L. Thompson (Vice-President),
J. F. Millican (Sec.-Treas.),
H. P. Ruggles,
A. A. Somerville,
D. L. Polack,
G. Rumble.

BOTTOM ROW:—

J. H. Ryan,
E. G. Willard,
S. W. Perry (Manager),
Prof. E. A. Allcut (Hon. President),
E. F. Connolly,
A. D. Turnbull (President).

INSERT

Prof. T. R. Loudon (Hon. Vice-President)

As a result of the inter-year tournament School sent in a strong team to the Junior Interfaculty Assault, and succeeded in winning the meet. Lloyd and Stephens again won their bouts in decisive fashion.

The Senior Interfaculty Assault-At-Arms brought out the old stand-bys of School. Hubbard, Jeckell and Grenzebach, demonstrated the versatility of the Engineers by winning their classes in boxing, wrestling, and fencing respectively. The good work of the other S.P.S. entrants enabled School to finish third in the meet, which was won by O.A.C.

That they are real champions was shown when Hubbard, and Jeckell, both won the Intercollegiate titals at McGill in February. Both of them had to meet two doughty opponents, and, in defeating them, proved that they are among the best on the strongest team Varsity has had in years.

Both Hubbard and Jeckell represented Varsity on the trips to Guelph and the States. Jeckell was one of the two Varsity wrestlers to win at West Point, while Hubbard defeated a clever man at the Boston meet. These two have another year at School and should have no difficulty in repeating their stellar performances of this season. Altogether S.P.S. has a royal chance to lead the field in the manly arts next year, and all that is necessary is for those who are interested in boxing, fencing, or wrestling to get down to work early and step into the tournaments with the old School spirit.

It is especially important to have a large number of entries in the Senior Interfaculty Assault-At-Arms as every win, whether preliminary or final counts points, and a large entry list from School next year will bring home the Davidson Cup.

S.P.S. has always been to the fore in the glove and mat games, and it is up to the incoming years to keep her there.

A. M. Toye, Mgr.

SWIMMING AND WATER POLO

With the graduation of 2T3, School lost practically all her "old reliables," and it was necessary this year to fill the ranks with untried material. The call was answered with the old time School spirit, and although we did not succeed in bringing the Fitzgerald Cup (Interfaculty swimming trophy) back to its original home, the team performed very creditably.

Chorolsky and Hill were the surprise of the year, the former setting a new Interfaculty record for the 100 yards breast stroke, with Hill taking second place, just a fraction of a second behind him. By dint of hard training Hill proved to be Varsity's best representative in the breast stroke, and next year should be quite an asset to the team.

In the speed events the team was somewhat handicapped by Cliff Booth having broken his wrist in a water polo game. Keefler won the 50 yards speed and took second in the 100 yards.

Mac Langton gave a very creditable performance in the diving, and although he didn't place in the Interfaculty meet he showed that he was of Intercollegiate calibre.

Kerr represented School in the back stroke event, and the remainder of the team consisted of Thompson and Kingsmill.

The water polo team was composed of Little in goal, Jeckell, Booth and Hill defense, Kingsmill centre, Coleman (captain), Drummond, Thompson and Keefler forwards, played a fine game right through the series, and played off with senior U. C. for the Echart trophy, representing the Interfaculty Championship. The calibre of the team is proved by the fact that S.P.S. were the only team to score goals against U. C. during the whole season; the score of the final game was 5-3 for Senior U. C.

Two members of the S.P.S. team, Kingsmill and Keefler, made the Varsity water polo team.

Next year it will be necessary for "School" to make a still greater effort if our old reputation is to be upheld. It is up to those who remain behind to see to it—those who are leaving will be with you in spirit and wish you the best of luck.

R. H. KEEFLER, S.P.S. IV.
Pres. U. of T. S. Club.

BASKETBALL

Tough luck, School! Who wouldn't say so if he had watched Senior Meds. get a field goal in the five minute overtime period against Jr. School. Our little bunch of hearties had been fighting hard to retain the Sifton Cup, won by their team the year before, and it was pretty hard to crawl up on Sr. Meds. in a semi-final game, tie them, and then lose out by a single goal in overtime. The team was pretty well balanced until Dow was taken sick, and they felt his loss keenly. But when he came back for the last few games they certainly got together and played the game. Just hang on Jr. School and next year you won't miss it.

The team consisted of Dow, Patterson, Willard, Ryan, Ballachey, Roelofson, Rogers, Davies, Grime and Lally, manager. Willard and Patterson played on the intermediate O.B.A. Team, and showed some very fine defensive work in combination and blocking. Ryan and Ballachey were both on the Varsity Juniors, and made a name for themselves on their shooting and passing.

Lloyd, of Senior School, played on the Varsity Intercollegiate seconds, and whenever he was watching a man there was a noticable lack of scoring from that sector. He makes an excellent defence player, although he has been used on the forward line in previous years with school teams.

Senior School had a team that should have gone through, without a doubt, to the top. That was the impression from the first. But, later on, when Lloyd left, the team was without a sub-forward as the third man, Pollack, had the misfortune to injure his knee and missed the most crucial game. Otherwise, the defence was the finest and hardest working pair

that has played in the Sifton Cup Series for some time. Nearly all the points scored against Senior School were from outside defence or from some defence player or centreman. As a summary this team was almost perfect defensively, but weak on the attack.

The team was made up of Turner, Little, Simpson, Hyland, Sorby, Shields, Norman and Pollack.

In their group Senior School ran up against Jr. Arts, who had, nearly to a man, been playing on some Varsity team. It just goes to show that those that have time, and play basketball only, can get out and practice on the big floor long before men who are playing rugby, soccer and doing track work, or rowing. With very few exceptions the School basket-ball men all take part in fall sports. None of these games require half the lightning co-operation of brain and muscle that basket-ball demands, and for this reason it takes some time for a man to force himself to get any snap into a basket-ball practice.

Therefore, every basket-ball player in School should remember that a great deal depends on getting arranged early in the year. It is only fair to the teams and their managers to give them time to really make some plans for outside coaching and games. School has plenty of athletes to win every cup that has ever been offered for competition in old Varsity, and with such a healthy looking prospect in basket-ball and every other sport, when have we a better chance of another "All Championship year," than next year. There are School men in on everything, running everything, and if we would all get together and play the game, and forget how our hair looks we can't help but take the front seat. That's what School is famous for What does the man on the campus say, "Gee, you fellows have a good time;" Funny isn't it? Too bad we are not more conceited.

Then let us use our winner of last year, "The old fight in there gang," and put School back on the Sifton Cup again.

G. W. SMART,
Mgr. Sr. School.

ROWING

For the fourth successive year the Championship of Canada is held by the University of Toronto Rowing Club. If it is won again this year one of the four sides of the base of the Hanlan Memorial Trophy will be all U. of T.

The last victory was more than a win because it practically showed that by a matter of five lengths of open water, no other club in Canada can represent our little old Dominion at the Olympic Games in Paris. What has that to do with School? Well, just half the crew are School men, and the man for whom the finest athletes in the University have worked themselves black in the face is a School man—Coach Tommy Loudon. It is his fault, and his only, that the University has been winning national and international fame for the last four years.

Here's hoping that our Senior Crew comes through with flying colours in their trial races on the 14th of June, and stand without a par at Paris in the Olympic Games.

The crack crew had bad luck of the worst kind. They rowed the the closest races that was ever rowed on the Canadian course. Five crews finished within a length and a half of the first. Our crew crossed over some shallow water and fell behind in the first half of the race, but got together and pulled up over two lengths to finish fourth.

The crack crew had bad luck of the worst kind. They rowed the whole course with a badly cracked oar, and didn't know until afterwards what was spoiling their swing.

The crews were composed of the following men:—

SENIOR CREW—Wallace Bell (S.P.S.), Langford Smith (S.P. S.) Snyder, Taylor, Little (S.P.S.) Heustis, (S.P.S.) and Campbell, cox.

JUNIOR CREW—McQueen (S.P.S.) Hunter, Russell, Turner, (S.P.S.) Thompson (S.P.S.) Amyot, Mills, Armstrong and Smart (S.P.S.), cox.

TACKS— (140 lbs.) Baxter (S.P.S.), Wolsey (S.P.S.) Webber, Seabourne (S.P.S.) Bowles, Sirrs (S.P.S.) Murray (S.P.S.) Fisher (S.P.S.) and Rutnam, cox.

Rowing has come to stay. So much so that our Club has enough equipment to run a fall interfaculty regatta. Each Faculty is forming their own Club and School is right up with the best, and should have at least two crews entered.

An interfaculty regatta was held in the fall of 1920, and School won the final race against Victoria. So this time it should be first and second by the look of the material turning out at present.

Just a word here about turning out. The crews will be made up of men of every size and weight. All that is needed is to be able to pull your own weight and a little more for the coxwain. So everybody will get a chance to show their waves. Training will commence immediately on the opening of School, so get in touch with your year representative at once and he will give you particulars about the necessary requirements. Any of the executive will be glad to hear of any enthusiasts.

The Rowing Club consists of the following:—Honorary President, Boyd Little, '20; Honorary Vice-President, Art Bell, '23; President, George Smart; Vice-President, Scotty Bruce; Sec.-Treasurer, Dick Fisher; Fourth Year Rep., Fred McQueen; Third Year Rep., Ted Nugent; Second Year Rep., Reg. Rochester.

G. W. SMART, President.

School "T" Holders

Baxter, W. F., 2T4	*Rowing*
Campbell, L. D., 2T4	*Soccer*
Chadwick, A. R., 2T4	*Gym.*
Firth, H. E., 2T4	*Lacrosse*
Greey, S. M., 2T4	*Tennis*
Kingsmill, C. G., 2T4	*Eng. Rugby*
Russell, N. E., 2T4	*Eng. Rugby*
Sirrs, R. R., 2T4	*Rowing*
Thompson, G. A., 2T4	*Hockey*
Zimmerman, A. H., 2T4	*Rugby*
Wolsey, M., 2T4	*Gym.*
Grenzebach, S. L., 2T4	*Fencing*
Clark, W. H., 2T4	*Wrestling*
Pentelow, H. M. S.	*Eng. Rugby*
Morrison, C. A.	*Track*
Smart, G. W.	*Rowing*
Turner, W. I.	*Track*
Turnbull, A. D.	*Track*
Thompson, W. L.	*Rowing*
White, R. M.	*Rugby*
Kirn, K.	*Gym.*
Chorolsky, E.	*Gym.*
Jechell, A. W.	*Boxing*
Hubbard, C. B.	*Boxing*

INDOOR BASEBALL CLUB

In view of the fact that it is a comparatively new sport to Varsity Spaulding Cup produced excellent games, and the competition was close and the playing floor limited in size, the indoor baseball schedule for the throughout. Faculty teams were arranged in three groups. School's Junior team with Jr. Arts and Jr. Dents, while Senior School were with Sr. Dents, Sr. Arts and Trinity.

The Jr. team managed by C. A. Morrison, made a strong bid for group honours, but were beaten out by Jr. Arts. There was much good talent on this team and they may be depended upon to be strong contestants for the championship next year.

The Seniors, after twice winning from Sr. Arts, who had in turn beaten and tied Dents in the two scheduled games, were not able to realize an ambition of many years standing, viz: put their old rivals, Sr. Dents, out of the running. For several years these two teams have met in the group eliminations, and each time the Dental team seemed to be favoured by Dame Fortune, and were returned the winners. It is interesting to note that Sr. Dents have won the championship for three consecutive years.

In winning their group Meds. earned the right to play off with O.A.C. in the semi-finals. O.A.C. produced one of the best all round teams ever in the series, and were easy winners. They won the first game of the finals with Sr. Dents, who put Jr. Arts out in the semi-finals. However, Dents came back strong, winning the second game and also the play-off, which gives them the Spaulding Cup for another year.

The Senior team had on its line up many of those who have played in this series in all their years at School.

Dow, Berner, Norman, Henderson and Williamson are all "old-timers" and all played the consistently good ball of which they are capable. The battery, Little and Lloyd, of third year, were as good as any, and as they are still available for another year will provide the nucleus for a strong team to go in and win the Spaulding Cup for School for the first time. Wilson was a new comer on the team, but his performance this year shows that he should have turned out since his first year.

Let everyone who even suspects he can play this game turn out next year and put two School teams in the finals, the devil take the hindermost.

W. L. SIMPSON.

U. OF T. RIFLE ASSOCIATION

The Association was organized March 4, 1904, twenty years ago. It is a purely civilian organization, and its purpose is to familiarize students in the use and markmanship of the military rifle (Lee-Enfield at present).

The Dominion Government supplies ammunition, rifles and incidentals, also the use of the outdoor range at Long Branch during the fall. The Association also owns the indoor range at Hart House, which, for its size, is one of the finest and best equipped in the country.

The Association was inactive during the war. Prof. Lash-Miller, the Hon. Captain, carried on as Secretary-Treasurer, looking after the interests of the Association, and keeping the spark alive.

A reorganization meeting was held in October, 1920, and the Association once more became a strong and active part in the University cosmos.

Prof. J. R. Cockburn and Prof. T. R. Loudon were largely instrumental in bringing this about as well as fitting and equipping the indoor range at Hart House.

This year School had 35 members, an increase of 10 over last year. The fellows turned out regularly at Long Branch during October and November. As a result School was successful in winning the three Interfaculty matches by a comfortable margin. This meant that the Delury Shield, which has been in possession of the Rent's since 1920, is once again in the Old Red School.

Science was also well represented on the Intercollegiate team, six of the eight members belonging to S.P.S.

The Intercollegiate match was held the Saturday before Thanksgiving, due to the day and the fact that weather conditions were poor, the scores were not as good as last year. McGill won the match and now hold the cup for 1924.

Shooting in the indoor range started in December; on Monday, Wednesday and Friday nights, from 4 to 6 p.m.

Gallery practice ammunition and Lee-Enfield rifles are used.

An indoor match was held in February with the C.O.T.C., U. of T. Rifle Association winning by a comfortable margin.

Three indoor Intercollegiate matches are to be shot, one in January, February and March respectively.

	Jan.	Feb	Total	Possible
U. of T.	927	926	1853	2,000
McGill	900	914	1814	"
R.M.C.	918	899	1817	"

U. of T. is 34 points ahead and appears to have an excellent chance for the first prize. The league is slightly smaller this year, Queen's and U. of Manitoba being absent.

J. D. BURBANK,
"School" Rep. of the U.T.R.A.

TENNIS AND SQUASH

The University and the Intercollegiate Tennis Tournaments were held at Toronto this year, on the courts of the Toronto Lawn Tennis Club, and were most successful. U. of T. was second to McGill, McGill having three players of a calibre not often found in Intercollegiate Tennis. The Varsity Team would compare favorably with any of the teams that have represented this University, and were considerably better than average players.

Tennis here is a sport in name only, as practically no tennis is played at the University during spring session. The season is not only bad for tennis, but there are not more than half a dozen courts available. In comparison with Oxford, where the number of courts runs into three figures, tennis here might be said to not exist.

School was well represented in the University Tournament, having a large share of the entries. The runner-up in the tournament was a School man. Also School was represented on the University team; so that of the tennis that is played here School has a large share.

This year squash at the University has come into its own. This game is one which is admirably adapted to student life. The exercise is very condensed, a half hour three times a week will keep one in good physical trim. Its a game that requires a keen sense of sportsmanship, and may be carried on long after undergraduate years; in fact, it is said that of the ten best squash players in England the majority are over forty years old.

No game has had the sensational rise in popularity at this University as squash, and the fact that over three hundred and fifty now play squash is all the more striking, when one remembers that there are no colours given for squash, and that there is some expenditure connected with it.

Squash players, of which School men comprise no small number, are pressing for more accommodation, the present accommodation being about one third that which the number of players justify. It is hoped that this will be rectified in the near future.

School men have shown their interest in this game by the large number of courts which are reserved every day by them, and by their prominence on the squash challenge board.

S. M. Greey.

CHESS

As the name implies, this club is a University organization and is not exclusively a "School" club, as a cursory examination of the member-

ship and officers might lead one to think.

The principal officers in the club for the season 1923-24 are as follows:

Honorary President ..... Dr. R. D. Rudolf
Acting President ..... J. D. Burbank, Sc. III.
Secretary-Treasurer ..... W. H. Coulter, Sc. III.
Graduates' Representative ..... C. E. H. Freeman
Staff Representative ..... Prof. Needler
Team Captain ..... C. H. Meader, B.A.Sc.
S.P.S. Representative ..... C. T. Haultain, Sc. III.

Warden Bickersteth of Hart House is also an honorary member.

It might not be out of place to state here the aims and purposes as well as the achievements of the club. The idea of its inception was to provide, not only a playground for the graduates or older adepts at the game, but to give the interested undergraduate an opportunity to equip himself with suitable weapons that he might enjoy the best of indoor games to the fullest degree. To this end, it is a rule of the club to accept whosoever offers it an entrance fee, as a bona fide member with full privileges; and also, in case he is a raw beginner, to furnish him with the necessary instruction to improve him play to a point where he can sit down with other more experienced players of the club and play intelligently and interestingly. This latter policy has been observed somewhat more closely this year than others, with the result, that the membership of the club contains a greater percentage of beginners than is previously remembered. Despite this, there are still many longing souls wandering the campus thinking themselves unfit to associate with real chess players. One often meets this kind, using the South Common Rooms at noons or at five o'clock, playing a friendly game—but just try and sign them up as members.

The Toronto Chess League, which prior to '22 had been running for several years, was dormant during '22 and '23, so that last year, the club had to seek other ways of creating interest. This year, however, the league came back to life, and op top of the other activities planned, have made this season a very active one for the club. As has always been the custom, the club entered an A and a B team in the league. This year the number in each team was set at five instead of six as previously. The A team consists mostly of graduates and the B of undergraduates, there being no set rule other than that a man may not play again in the B team if he has played twice during the season on an A team. These matches have not all been played off to date, but since the B team has not lost a match so far, it is likely they will come out on top. The A team however, is unfortunately, not so lucky.

The Theosophical Society, 52 Isabella St., challenged the club to a series of three friendly matches to be played when convenient. As the first of these matches resulted in victories for Varsity, the third was unnecessary.

Each year an undergraduates' open tournament is run. This year a slight departure was made, in that no fee for entrance was charged to the members, twenty-five cents, however, being collected from any others

who wished to enter. Prizes will be given to the winner, runner-up and best novice. The greatly increased number of contestants this year over last, is proof of the value of the policy regarding the fees.

Due to the very active term, the numerous expenditures and the lack of spare time or cash on the part of its members, the club unfortunately had to let pass an offer to play the University of Buffalo Chess Club. A match with them next year will probably be arranged.

It might be well to point out that the majority of members and officers of the club are school men. This is taken to conclusively prove that the game is scientific and not an art. The fact that the game requires initiative, imagination, an accurate conception of mathematics and a sense of what is safe and what is otherwise, probably accounts for the increased interest taken in the game by students of the "Little Red School House."

W. H. COULTER,
Secretary-Treasurer.

BALANCE SHEET
of
THE UNIVERSITY OF TORONTO, ENGINEERING SOCIETY
As of February 29th, 1924

ASSETS

CURRENT			$7,413.01
Cash		$ 316.89	
Bank (Current)		902.18	
Bank (Savings)		1,143.62	
Victory Bonds		1,000.00	
Accounts Receivable	$139.00		
Less Reserve for Depn.	20.00	130.80	
Mr. Lyle Loan		24.00	
Debating Club		10.00	
Mr. Chadwick		128.00	
Mdse. Inventory		3,769.07	
		$7,413.01	
FIXED			524.29
Office Equipment	$624.29		
Less Reserve for Depreciation	110.00	$514.29	
Smoking Room Furniture	70.00		
Less Reserve for Depreciation	60.00	10.00	
		$524.29	
			$7,937.30

UNIVERSITY OF TORONTO, ENGINEERING SOCIETY
LIABILITIES

CURRENT		$2,274.61
Account Payable	$2,178.54	
Allen Crawford Memorial	96.07	
	$2,274.61	
LIABILITY TO ENGINEERING SOCIETY		5,662.69
Surplus Account	$4,615.06	
By Profit & Loss Account	1,047.63	
	$5,662.69	
		$7,937.30

UNIVERSITY OF TORONTO, ENGINEERING SOCIETY
TRADING ACCOUNT
For Five Months ending February 29th, 1924

Sales		$10,945.86
Mdse. Inventory, Oct. 1st, 1923	$ 2,800.00	
Mdse. Purchases	10,351.58	
	13,151.58	
Less Inventory, Feb. 29th, 1924	3,769.07	
	9,382.51	
Salaries	690.00	
	10,072.51	
Gross Profits to Profit & Loss	873.35	
	$10,945.86	$10,945.86

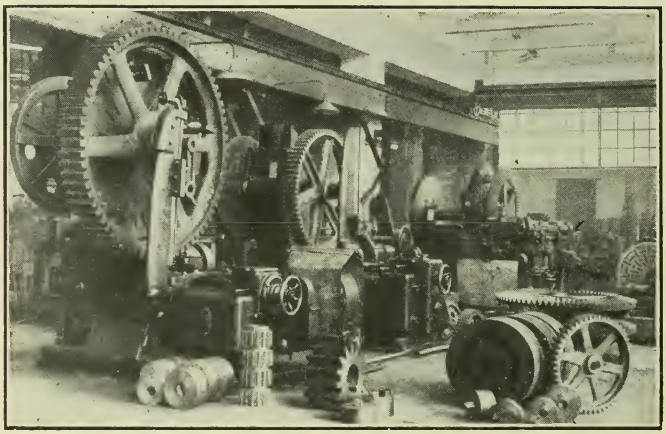
PROFIT & LOSS ACCOUNT

Publications	$ 248.05
General Expenses	499.87
Dinner Deficit	7.82
Dance Deficit	66.99
Grants to Clubs	25.00
Community Night Deficit	190.42
	$1.038.15
Net Profit to Surplus*	1,047.63
	$2,085.78
By Gross Profit from Trading Account	$ 873.35
" Fees	1,132.00
" Interest and Discount	80.43
	$2,085.78

Cut Gears

& Gear Drives

Of all kinds and in a
large range of sizes



Capacity:	Spur Gears	to 16 ft. diameter
	Internal Gears	26½ ins.
	Bevel Gears	62 "
	Worm Wheels	52 "
	Helical and Spiral	51 "
	Racks	25 ft.
	Boring Mill	18 "

Hamilton Gear & Machine Co.

CHESTER B. HAMILTON, Jr., B.A.Sc., '06, M.E., President

76 VanHorne St. - TORONTO

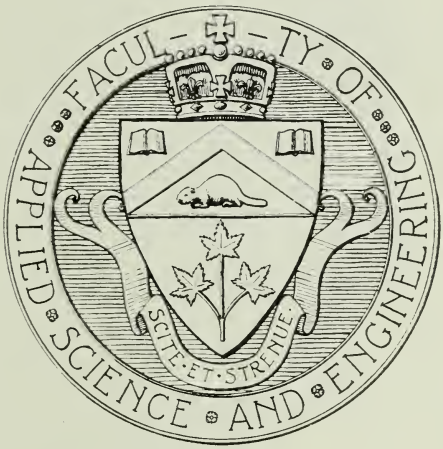
No. 38 1924-25

The Transactions

of the

University of Toronto Engineering Society

With which is incorporated the APPLIED SCIENCE



PUBLISHED BY THE SOCIETY

THE LITTLE RED SCHOOL HOUSE

620 6
TOR
1924/25

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Standing: D. C. Beam (Secretary-Treasurer), C. W. Dillane (Associate Editor).
Sitting: S. M. Jones (Assistant Editor), W. R. Chowen (Editor-in-Chief), C. W. Gordon (Associate Editor), J. Lindsay (Business-Manager).

Transactions and Year Book

of the

University of Toronto Engineering Society

With which is incorporated "Applied Science"

PUBLISHED ANNUALLY BY THE SOCIETY

No. 38 TORONTO, APRIL 15, 1925 Price 50c.

W. Roy Chowen - - - - *Editor-in-Chief*

Stephen M. Jones - - - - *Assistant Editor*

C. W. Dillane *Associate Editor*

C. G. Gordon *Associate Editor*

J. Lindsay *Business Manager*

D. C. Beam *Secretary-Treasurer*

Editorial

The "Transactions and Year Book of the Engineering Society" as the official organ of that Society, has seemingly come to stay, in so far as its present form is concerned, at least. Indulging in a little retrospection of the history of this volume one is struck with the appearance of evolution. But evolution is a slow process and at best merely represents the work of chance or conditions existing at each step. It is not to be supposed that evolution in this case means an advancement in perfection. We fondly hope it does. Indeed in our less rational moments we feel that this, the product of our earnest and concentrated endeavours, could not be otherwise. But always there comes the cruel pitiless light of saner perception, and so with befitting humility we offer you this, the fifth issue of "Transactions" as an Annual.

You will find one section missing, that of the "Old School." To run another ten years would almost encroach on our own days here, and interest might flag.

The addresses given before the Engineering Society occupy the first part of the book and are reproduced with meticulous care. One or two of the addresses were illustrated with lantern slides and diagrams to such an extent that the address in print would be quite pointless without them. Thus we have been compelled to leave them out. A few other papers are included in this section,

which are explained by footnotes, and for these papers we owe a debt of gratitude to the authors. The second and last part of the book is more pertinently "School." In brief it is our Year Book, and as such constitutes another page in the history of our Faculty. To the undergraduate it presents, in permanent form, a record of his interests during one of his years here. To the graduate it forms a connecting link with his beloved "School" and keeps ever before him her progress, in realms which once took such heavy toll of his own time and enthusiasm.

And so we give you "Transactions." May you find in reading it some of the spirit of untiring energy and unselfish effort of those men who, by their activities here, made it possible for the Board in our role of historians to compile such a volume.

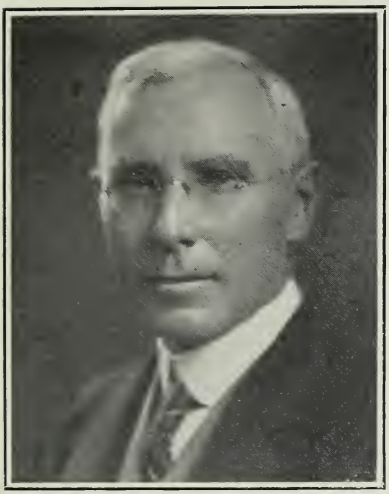
Service

Perhaps the most prevalent trait of character amongst students is that something which makes him say to himself, "I will not be a servant, I will climb to great heights where others will serve me."

There was once a man who decided on exactly this course, so he began by studying the life of the foreman under whom he worked in order that he might qualify for this position. Presently he was promoted to such a position only to find that he must take orders from a whole staff of higher officials. Undaunted he aspired to the office of superintendent, and later to general manager, but here again he was made responsible to practically the entire executive.

Mystified he decided to consult the president of the company. While attempting to interview him, several days were lost simply because the president was too busy looking after the people on whom he depended, to even see him for a few minutes. When this was made known to the young man, he was very puzzled for he knew the president to be the head of an extraordinarily large and prosperous corporation. He said to himself, "I will go to the Prime Minister of the land," for surely he of all people will be independent. During the resulting interview, they were continually interrupted by messengers carrying communication to and from the Prime Minister. "Who are these?" inquired the young man. "They carry messages to all parts of the land to appease the troubles of the people," was the answer. Then the young man had a bright idea and he said, "I will leave off trying to avoid service and serve as many as I can, for the number of people whom a man serves is a measure of his success."

The Dean's Message of 1925



The present year of the Engineering Society has been one of considerable progress and the types and quality of the papers and addresses given before it have been of a high order. I wish to congratulate the President and officers of the Society upon their efforts.

I wish also to congratulate the undergraduates and especially the year now graduating, in being here at this time. Those who are about to leave, and those who shortly will follow, will go out into the world at a time when they will be ready for taking advantage of the progress and the renewal of engineering activity which appear to be not very far distant.

The Engineering Society through the papers and addresses which have been presented, has afforded an opportunity for development apart from the purely academic. If graduates and undergraduates alike, carry this principle out with them, of broadening their general education and making the best use of all facilities to continually acquire engineering and other knowledge, they will progress in their profession well equipped for what they may be called upon to do.

Wishing all the members of the Engineering Society continued success.

(Sgd.) C. H. Mitchell,
Dean.

Address of Retiring President

GENTLEMEN:

Having all but completed our year's work this seems to be a very fitting time to give a résumé of the term's activities.

The regular meetings of the Engineering Society, addressed by some noted and able speakers, have been carried through without a break. The attendance on the whole has been fair, but might have been considerably better if the members took the interest in the Society's affairs which they should. It would appear that to have a large turnout at these meetings it is necessary to supply a sugar coating in the form of a speaker who, besides being capable, must be witty.

One item of outstanding importance at one of the last meetings was the gift by Mr. Allan Ross, in memory of Mr. Walter J. Francis, of his set of the reports of the Hydro-Electric Enquiry Commission. This gift is being placed in the Main Library, and will be open for examination as soon as the final arrangements have been made with the Librarian.

The Annual "School" Dinner in the Fall was a decided success in every way, except in attendance, as it resulted in a deficit. For the past few years this function has not received the support which it deserved, with the result that the question as to whether or not it should be dropped has become more insistent each year.

Every one who was at the Engineering Society At-Home, whether they arrived before or after one a.m., declare that it was the most enjoyable social function at Varsity this season. It is too bad that they are so costly or they might be held more often.

Thanks to the untiring efforts of a very capable manager and assistance of the club and year executives, the S.P.S. Stunt Night in Hart House lived up to the high standard set during the past two years. This year it was felt that we could not afford to put it on free of charge. A figure was set which we hoped would just cover expenses without even allowing a factor of safety.

A statement of the finances of the Society, shown elsewhere, will show how well the Supply Department has done up to the end of February. The sale of apples was a very popular innovation, but has aroused considerable dissatisfaction on account of the mess they make in the buildings. The daily sales have compared very favourably with those of last year. Our treasurer has cashed so many cheques during the term that he is beginning to think that he is a bank teller. It is very gratifying to note that nobody has taken advantage, wilfully, of this convenience, to pass off any valueless cheques.

The item this year which has caused the greatest amount of thought in connection with the Engineering Society has been finances. The overhead and general expenses have remained practically the same as formerly, while the returns from fees and profits have fallen as fast as the registration. The maintenance of the Employment Bureau, which was started for the class of 2T3, has been the chief burden. It was thought inadvisable to drop it after two years of good ground work had been put in, and that in the course of the year some new idea might come to light by which it could be run without the present financial embarrassment to the Engineering Society.

In closing, I should like to express my heartiest appreciation to the Dean and the different members of the staff for their valuable advice and assistance, and to the members of the Society's executive for their constant support and the capable way they carried out all their duties. I should also like to thank those who have given their time and energy during the term to carry out the plans of the Society, among whom are: "Jake" Tanton, who so ably managed the affairs for Stunt Night; Jim Lindsay, for his work as Editor of the *Toike Oike;* Harry Miller, for handling our section in *Torontonensis,* and many others.

(Signed) J. F. MILLICAN.

THE TRANSACTIONS
OF THE
University of Toronto
Engineering Society
WITH WHICH IS INCORPORATED THE "APPLIED SCIENCE"

No. 38 TORONTO, APRIL 15, 1925 Price 50c.

*ENGINEERING ACTIVITIES AND PROSPECTS IN CANADA TO-DAY

By Dean C. H. Mitchell

We are inclined to look on 1924 and 1925 as dull years for the engineer, but they are and will nevertheless be years of activity. After all there is a great deal of Engineering work going on in this country.

Let us make a review and think first of the engineering in connection with basic production and with the development of our resources which enter so much into our life to-day.

Agriculture.

Starting with these one cannot help thinking immediately of agriculture. It is after all the basic industry of our country and will for decades to come be the basis of our wealth. I would like to give you two ideas on this subject. Engineering has a great deal to do with making the land more productive, and some one has said that the man who does the most for his country is he who makes two blades of grass or grain grow and yield in the place of one. Second, the farmer to-day is getting more for his grain than at any time since the war; that means much to the whole country. When we reflect on these we realize how much there is to do for the civil, mechanical and chemical engineers.

The Metals.

As to iron unfortunately we do not produce very much at this time, but we are not far away from the time when methods are going to develop for utilizing our low-grade ores.

*Address to Society, October 29, 1924.

There is a considerable activity in copper to-day in British Columbia, Manitoba, Northern Saskatchewan, Northern Ontario and Quebec. In the new Rouyn field in Quebec there has been discovered within the last year a large deposit of copper ore. That means that the great copper, gold and silver region of Ontario is extending eastward into Quebec.

In gold there is tremendous activity in various parts of Canada. In British Columbia the outstanding mine is the Premier. In Ontario, at Hollinger and at Kirkland Lake there have been enormous increases in the past two years. The new Rouyn region previously referred to is also beginning to produce gold.

We are inclined to think of the old silver and Cobalt areas of Ontario as declining. Though this may be true for the Cobalt region silver mining is continuing very active in other localities and is specially productive in the Lorraine region.

A much discussed ore in British Columbia is the complex lead and copper ore. Methods of handling it have been devised so that what a few years ago was thought to be worthless waste material is now made productive on a paying basis. So too with other large copper deposits in British Columbia. The new and very large Kimberley mill has just been built to work up these low grade ores.

Transportation.

Four years ago we were in the middle of a very difficult situation with regard to our National Railways. To-day the Canadian National Railway is on its feet. It is getting on, improving each year and the last two years have seen a steady improvement. Last year there was a great deal of discussion about the extent to which new lines should be built for the C.N.R. out west. There is and always will be a demand for new lines, in certain localities at least, and there are at present either under construction or projected, upwards of two thousand miles of new lines. Engineering in this branch is certainly picking up.

The Toronto Viaduct question has been going back and forth for many years. Now (October 1924) an agreement has at last been arrived at, and the methods, proportions of cost and other financial features being settled, the project is about to proceed. Twenty-nine million dollars worth of work will thus be done right here in Toronto.

Another activity in Transportation is the construction of the new Welland Ship Canal. This Canal is the largest piece of

engineering work going on in the world to-day; it is the second largest canal work in the world, being second to the Panama only. It is being built almost entirely by Canadian University graduates. Its object being to fit into a gigantic plan to permit ocean-going ships to go through to the head of the lakes, the locks are of sufficient size to take ships over 800 feet long, 80 feet wide and drawing 30 feet of water. The Canadian Government is spending between eighty and one hundred million dollars on it and we are living in the middle of that huge work to-day without fully realizing it.

Within the last year one of the largest dry-docks on the Atlantic Coast has been completed in New Brunswick; Montreal harbour is very busy with new work, millions having already been spent building the St. Lawrence Ship Channel from Montreal to the sea. The Government and City have already spent nearly twenty millions on the Toronto harbour, and there is half as much again yet to be spent. Vancouver is well embarked on a very large programme of harbour work; the Dominion Government having allotted five million dollars to it this year. In Victoria there will shortly be completed a dry-dock, which will be among the largest on the Pacific coast. These instances give an idea of what is happening in this branch of Engineering.

Municipal Work.

Municipal work in progress to-day does not mean so much in money or magnitude, but it means much in the employment of engineers. There still are large programmes of highway construction both being built and repaired. The City of Toronto is adding materially to its water system at the present time, planning a fifteen million duplicate main system. Ottawa is progressing towards a new and comprehensive system. Hamilton has a large project in view. Toronto has also considerable drainage work going on and there is similar activity in the Border Cities around Windsor.

Structural.

Two of the largest bridge structures on the continent are now being built in Toronto, St. Clair Ave. bridge in Moore Park and the huge viaduct on Bloor Street west. At Niagara there is just being completed another steel arch railway bridge, built by the Michigan Central Railway over the gorge above the whirlpool rapids. In Montreal there is a new bridge project which is passing

through the preliminary stages; this is the construction of a high level bridge crossing the St. Lawrence from the heart of the city to the south side of the river.

Electrical.

The Queenston-Chippewa power plant is still being added to, three more units being now in process of installation; that also means a large amount of new work in connection with this magnificent plant. Another extensive hydro-electric plant, the construction of which is just now completed, is the La Gabelle plant on the St. Maurice River, eighty miles from Montreal. The units in this are thirty thousand horse-power each under sixty feet head. They are being built by our Canadian works and Canadian engineers and represent the latest designs in both hydraulic and electrical equipment.

A good deal of activity is in progress toward heat treatment electrically. That is one of the most prolific fields of study in electrical work which during the next few years will absorb engineers. Then there is also the change of our telephone system from the manual to the automatic system; most of that work is being done by our own Canadian engineers, many of them graduates of this University.

We now begin to realize what a unique place Radio has taken in our lives to-day. Even four years ago it was quite in its infancy, and there is no telling what the next four years will bring about. The Dominion Government is doing much already in employing a number of radio engineers. As one instance of the new use to which Radio is being put we observe its application to take the place of light-houses for ocean navigation. In England they are putting up new Radio directors and by radio beams they do the work of the light beams of a light-house. This is an application which has come within the last twelve months and its introduction may not be far off in Canada.

Mechanical.

There is great activity at the present time in the development of steam turbine work. Engines are now being built that have pressures of five hundred to one thousand pounds per square inch. A new mechanical development is the introduction of the new locomotives of the Canadian National. They have over two hundred control valves and levers; stoking is mechanical; they travel thirty-five or forty miles an hour and haul seventy-five to one hundred cars.

The development of the hydraulic turbine is also entering new fields, the propeller type for low heads being especially of interest and being installed in various Canadian hydro electric plants.

Architecture.

Attention is drawn to two large sky-scraper buildings going up in Toronto to-day, one twenty stories and the other sixteen. Modern and up to date in every particular and full of mechanical and electrical equipment they represent very considerable activity in this branch of architecture. There is also the new Manufacturers' Life building on Bloor Street East, a very substantial and magnificent piece of work representing a new type of architecture in this city.

Chemical.

In Chemical Engineering, while the activities are not as numerous or perhaps as extensive as a few years ago, there is a large field. For instance there is an enormous amount of paper being made in this country. The rubber industry also absorbs many chemical engineers. There is also great activity in the paint and varnish industry and in sugar, packing-house and food products generally. There are also the tanning, dyeing and other tinctorial chemical industries. All of these show considerable activity although in a limited degree owing to restricted markets.

Prospects of the Future.

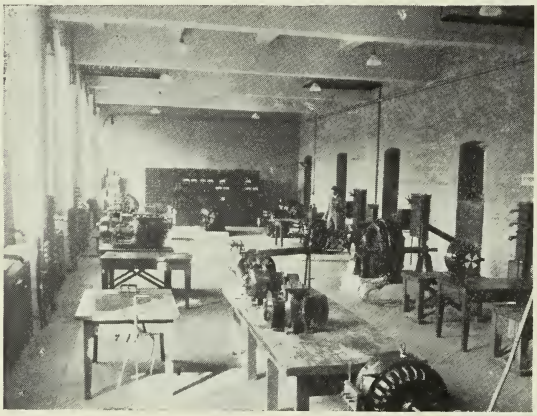
One of our great Canadian assets to-day lies in the "Precambrian Shield" geological formation to the North. It is hard to tell what a few years further exploration and development will bring forth from this rich area.

Before the war there was considerable employment in Civil Engineering but since then it has been much restricted. I believe, however, that in five years time Civil Engineers are going to be engaged in greatly increased activity and everything points to a return to large construction in due course.

Think for instance of the possibilities of the huge St. Lawrence Waterway project. You students who will then be graduates must be ready for that when it does come. You are going to be involved in work in connection with it in some form. It is hard to realize the magnitude that project will be. Besides the huge power possibilities of the St. Lawrence the navigation portion of the St. Lawrence project will be the largest thing ever attempted ex-

cluding the Panama canal. The two countries involved have recently agreed to make a complete study of the project and an International Board of Engineers is now engaged on it.

I wish to conclude by impressing on you the idea that no matter how quiet engineering prospects may appear at present, you are approaching a time, perhaps not very far distant, when great activity in all kinds of work will be resumed. I leave it with you at that.



VIEW OF ELECTRIC LAB

*TOWN PLANNING

Horace L. Seymour

I think, gentlemen, that we live in a fortunate age. I feel that we engineers are living at a better period than when I graduated. I sense this fact,—the engineers are taking a broader interest in public affairs.

There are many movements afoot in Canada and throughout the world of which the engineer should have more than the ordinary knowledge. About twenty years ago there were two such new movements in Canada; one was the good roads movement, the other the inauguration of Horticultural Societies throughout Ontario. There were many pessimists who said the roads were all right as they were, but we know what we have now. Many of our roads are the envy of our cousins to the south of us, whereas a few years ago we had to go into the States to find good roads. It was a movement in which every engineer was expected to take part or at least to give his sympathy. Regarding the Horticultural Societies, a few years ago we had 30,000 members in Ontario.

Town planning is at this time in somewhat the same situation as the other two movements. It will become something,—as we are sure now that the other two have had an effect on our country. In the States there are one or two universities which devote considerable time to town planning. The best definition of "town planning" is to show you some of the work that has been done. Planning is simply the scientific way of engaging in any art. If we plan for buildings we call it architecture, if we plan for gardens we call it landscape gardening. It includes the surveyor and most particularly the engineer. One engineer said town planning was 80% engineering. The best verbal definition I can give is "community foresight"; looking ahead by planning now to save expense in the future; the orderly arrangement of land and buildings and the utility serving them, the object, of course, being economy and better social conditions.

One phase of the subject, the spectacular phase of it, is the replanning. We probably find most interest centred on this feature.

Here slides were shown of the results of the Halifax explosion, the proposed reconstruction of the area, and of Haileybury after the fire. Mr. Seymour pointed out some of the old faults and mentioned proposed improvements. These slides were followed by a number of others showing various plans and problems, including that put forward by Sir Christopher Wren for rebuilding London after the Great Fire, concluding with a series showing replanning to relieve congestion in New York.

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*Address before Society, Jan. 28, 1925.

*ENGINEERING ON PACIFIC COAST

Dr. W. F. Durand

One of the larger engineering undertakings in which we are interested on the Pacific Coast is the problem of the Colorado River. This presents a very live problem in the States and is receiving a good deal of attention in Washington, though the politicians there usually succeed in blocking what the engineers put forward.

This particular problem is quadrangular. The first angle is the protection of the inhabitants of the Colorado River Valley. This valley was a desert waste a few years ago; now it is the centre of a very populous farming community. The people have invested their all and are living under the constant menace of the river flooding. In 1905 there was a break in the bank of the river and a great deal of this territory was put under water. It cost millions of dollars to reclear this territory. In its lower reaches the Colorado River is flowing on a very slow gradient, and carries a large amount of silt. It is tending to move to one side or the other. This river is flowing through an elevated trough; before the people can control it the river breaks through and flows over the valley. The people feel that they are living under a direct menace, and they have appealed for protection from it.

Another angle is the actual existence of four million acres of territory which could be profitably irrigated by the Colorado River.

Regarding the third, those who live here, where the annual rainfall is thirty or forty inches, are not always able to realize the absolute dependence of the progress of civilization on an adequate supply of drinking water. The city of Los Angeles, some twelve or fifteen years ago, constructed an aqueduct bringing water from the mountains, aggregating a quantity to supply two million inhabitants. They thought they were adequately supplied for a long, long time, but there have been dry years, and the supply which was expected to last so long, cannot be safely depended on. The city is growing and the original supply intended for two million will not be sufficient to meet the demand. The present population is over one million; at the rate at which the city is growing, and assuming that possibly the present supply will not be adequate for 1½ or 1¾ millions, it is already time for the city to stir itself in regard to finding another source of drinking water. The only place is the Colorado River.

The fourth angle is the question of the supply of electric power. The demand for it has been increasing at a compound interest rate of somewhere between 15 and 20%. The consumption of electric power increases 4½ times as fast as the population. Los Angeles is undergoing that transformation. The very rapid increase of

*Address before Society Jan. 11, 1925.

power consumption in Los Angeles, and half as much again in surrounding smaller towns all growing at about the same rate will soon result in the present supply of power becoming entirely inadequate. Unless power does become available it is perfectly evident that the supply from our now available sources will very promptly become used up, and then we can't tell what will happen. An undertaking such as that which is contemplated in the river will take a considerable number of years to bring to a conclusion. It seems perfectly safe to count upon a consumption which will practically absorb the supply, just about the time when it will be ready for delivery. I should not, of course, leave out of account certain demands in the States of Arizona and Nevada. In Arizona power is wanted right now. Between Nevada, Arizona and California there is no doubt about the market for this power.

In what way can the river be made to meet the conditions of this problem? It flows south and west into the Gulf of California. Its total length is 1,750 miles from the head-waters of the largest stream. The average rate of flow is about 1/10 the average rate of the Niagara, but unlike the Niagara it is subject to extreme fluctuations. The total annual discharge of the river is seventeen million acre-feet. Half of this discharge might easily come during the flood period. The river carries a very large burden of silt, 80 or 90,000 acre-feet per year. This burden of silt is a very important factor in any development in this river. With regard to the protection of the Imperial Valley, it is obvious that the danger will come with the flood. If we can reduce the flow to 80 second-feet we shall have succeeded in adequately protecting the Imperial Valley. At one point on this river, where it turns and begins to flow south, the river flows through a canyon, the walls of which are 2,000 feet high. The width of the canyon at water surface, at low water, is 300 or 350 feet, widening out as the level rises. It is an ideal place for putting in a great cement plug, and thereby forming a dam. It would be something of the order of 600 feet high above mean low water level, and would go about 600 feet below. This dam would result in a reservoir, the cubic contents of which would be about 31,000,000 acre feet. As for the rate of inflow and outflow, it has been clearly shown that with a flow down the river of 60, 70 or 80 second-feet, it would be possible to accommodate 250,000 second-feet at the maximum. This dam must never be allowed to overflow.

With reference to irrigation, if we can regulate the river flow we can also regulate the discharge for irrigation. This will not happen for a long time.

In the matter of setting this reservoir. It must be a very long reservoir with a long range for stilling the water and dropping the silt. The silt will be dropped long before the water reaches the dam itself. Supplementary reservoirs could readily be provided. These provide the basic requirements for the water supply of the cities of California.

It would be possible to develop about 600,000 horse-power throughout the year, assuming that there is a market for this amount. It is expected from experience that in the power system we should be able to supply this power on a low factor, 60% of maximum. There are a lot of problems of great interest which arise in this connection, all kinds of problems of the transmission of power. If power from the river should have to be sent five or six hundred miles, it would undoubtedly require higher operating voltage. There would be no trouble in marketing the power and it would be sold at a figure attractive to users of power in large or small quantities.

Growing out of these basic problems are many smaller ones. The whole question is attracting quite a bit of attention. Hydro power represents a draft on an annual allotment given us by the sun. When we use coal and oil we are drawing on our principal, and there is only one end to the man who keeps drawing on his principal and does not replenish it. It becomes doubly important that we should see to the conservation of natural resources in order that we may extend their utilization over the longest possible period of time.

ELECTRICAL BUILDING

*PROMOTION OF ENGINEERING EDUCATION

By W. E. Wickenden

I am going to talk to you this afternoon about a big business. A business carried on at 150 different centres of production; a business which engages the nearly exclusive attention of 70,000 people; which represents a capital investment of $150,000,000. The annual expenditure going into the product of this business is somewhere near $50,000,000. You see, it's the biggest kind of a business, Engineering Education.

There are about 60,000 students and five or ten thousand teachers engaged in this business. The product? Nine thousand men who complete their courses and receive their degrees every year. However, besides this direct production there are by-products. That is one of our problems. It is perfectly plain to anybody that any business as big as this is could be run better. No business in the world is run so well that there is no need for improvement.

Education is something in which we walk almost entirely by faith and scarcely at all by sight, and those who are most entirely engaged in it must sooner or later have misgivings about it. Throughout the entire length and breadth of the business there are very real misgivings as to whether we are doing this job in the right way, or not; if those most directly concerned are the right ones for the job. We are asking ourselves, "Is this organization well set up? Have we got the right amount of balance between local initiative and general guidance? Should we locate our plants with regard to the raw material or to the market? Should our colleges be where the men are or the industries are?" It seems clear that we must take the colleges to the men, but we must still ask ourselves "Are our plants properly located,—are they getting the right kind of material to work on?"

There is a tremendous wave of enthusiasm for going to college on the American side. With a 40% increase in population between 1900 and 1920 the college attendance has quadrupled. This is most strongly marked in the agricultural rather than the industrial centres. The college-going habit has spread beyond the limits of the literary groups in society.

The public wants to know, "Do the plants have the right kind of facilities and enough of them?" Is the personnel which directs and operates these plants well selected, well trained, and is it picked by merit? Are we taking the right steps to keep it so?" We have to face that fact in Engineering Education.

We have to ask ourselves, "Does the product of this business meet the requirements of the market in kind and quantity?" Just what is the occupational demand for engineering graduates? The

*Address before Society Nov. 17, 1924.

industries are carrying on a survey of their requirements. This is what they are finding out: For men of broad general training and of promising personality and good human qualities, the absorbing power of the industrial market on this continent is very far below saturation. For men of high degrees of specialization the market supply and demand are properly balanced to-day.

We have to ask ourselves, "Ought some new requirements to be anticipated and provided for? Are there some new things that are going to develop in the industrial life of our country, and are we going to wait until the market is pounding on our doors before adjusting our education to meet the demand?"

We must ask seriously, "Are we producing as high a proportion of product as we should?" Four out of every ten who matriculate finish their course and get a degree. The rest go into the by-products. That represents a lot of waste. Perhaps the proportion is too high.

There are other questions: "Is the distribution of this product as good or as economical as it should be? Are certain industries being overfed with graduates and others being disregarded? Is the process by which we distribute good or bad? Isn't the transition between the time when some person is educating you, and when you get outside to educate yourself, rather abrupt?" That is part of the problem involved in the distribution of the product of the school, for there is no such thing as a finished education.

Let us ask ourselves, "Is the product used by the consumers as intelligently as it ought to be?" I dare say some of you have opinions on that. The better qualified and trained men are prone to assume that the fact that they are sought for places the whole burden of their success on the man who hires them. Let me warn you against it. Is society getting a fair return on the investment it is making in education? A survey has shown that it takes a college man 12 to 15 years to wipe out the four years mortgage society holds on him.

Another question, "Are we surpassing or are we barely keeping up with the progress that is being made by our competitors abroad?" This is clear,—the problem with which we are all confronted in the United States, Canada, and probably in Mexico, is the problem of more production per man. This is a continent where men are relatively scarce and materials abundant. We must have better organization of industry. But we have economic problems in connection with our materials. Are we using our coal to the best advantage? How long will the oil last? What is happening to the timber, the soil, and the water?

They are going to call on the engineer to solve all these, and for another very important service. They are going to call on him to make the spending process intelligent. This is a huge job. If it isn't the engineers, whose is it? Engineers are being called upon to bring more of the professional spirit into public life, Hoover, for

instance. And one thing more; the engineer of to-morrow has to face the problem of whether we can go on indefinitely assuming that mankind can adjust itself to civilization, or whether we can design civilization to accommodate human nature. If any of you have ever tried to ride on a New York subway at about five o'clock you will know what I mean. The men who built them calculated their loads, worked out their stresses, allowed their factors of safety, considered everything except the endurance of the people who would use them. Soon they are going to call on the engineer to adapt this civilization to humanity.

I think you are coming on the stage at a fortunate time. It is a great profession for which you are training; the profession of engineering. To-day the engineer is consciously accepting the responsibility for making civilization work, as well as building the machinery for it.

MINING BUILDING

NITRATES AND THEIR PRODUCTION

By Prof. J. W. Bain

While nitrates are found in small quantities in tropical countries, only in India are they recovered in commercial quantities. Here they are collected by very low caste natives who extract them from the highly manured soil, and by a crude refining process produce potassium nitrate or saltpeter. The amount thus brought on the world market is relatively small and may for our purpose be neglected.

In only one place in the world is there any considerable quantity of nitrates, in the northern part of Chile. You will recollect that this country stretches as a narrow strip 2,500 miles long and 40 to 200 miles wide along the west coast of South America. At the north end of the country, towards the Peruvian boundary and lying behind the hills of the sea coast, is a rainless desert of very considerable extent. About a century ago it was observed by travellers that the soil was impregnated with a white solid which, on examination, proved to be sodium nitrate, or, as it is usually called Chile nitre. In this region there has developed, somewhat slowly at first, a great industry devoted to the recovery of the sodium nitrate from the soil. When we recall that no rain ever falls in this district, and hence that there is no vegetation and that literally everything must be brought in from the sea coast by rail, the arid and uninviting nature of the country may be better realized. The soil is blasted out and loaded on railway cars, which transport it to the central factory, where it is boiled with water. There results a solution of sodium nitrate, which goes to the crystallizing tanks, and the muddy residue is thrown away. The solution, on cooling in open tanks, deposits the nitrate as snowy-white crystals. The product is shipped by rail to the sea and thence by ship to all the industrial countries of the world. When I add that in the year 1923 2,200,000 tons were exported from Chile, requi ing 110 ships making 4 trips per annum for this purpose, you will get some idea of magnitude of this industry.

During the war Great Britain, France and the United States were dependent entirely upon Chile nitre for the production of their explosives of all classes. How Germany and Austria managed we shall see later. With the commencement of the ruthless submarine campaign, the saltpeter ship from Chile became a specially attractive target, and for some time the dread spectre of a shortage in ammunition haunted the War Offices of Great Britain and France in consequence of the frequent losses of these precious vessels.

To-day sodium nitrate from Chile comes freely to Toronto and is sold either unmixed or as a constituent of practically all commercial fertilizers; 22,000 tons to came Canada this year. But it is a far cry to Chile, and the Government of that country, like all others, has close to its heart the problem of raising money. An export tax of $10.46 per ton is therefore levied on every ton exported,

and Canada has the satisfaction of helping to the extent of $230,000 to maintain the Government of Chile. It has been estimated that the Chilean deposits will be exhausted in about 100 years, which does not augur well for posterity.

And here we ask ourselves if there is no other source of nitric acid, and the answer is, "Yes, there are several."

Cavendish, while studying the composition of air, passed sparks from an electrical machine through air enclosed in a glass vessel and observed that nitric acid was formed. By continuing the passage of the sparks for a long time, and absorbing the nitric acid formed in lye, he was able to cause all the nitrogen to disappear, leaving only about $\frac{1}{128}$ part of the volume of the air which was taken originally. He was unable to explain the reason for the survival of this residue, and more than a century later Sir William Ramsay showed that the gas argon is present in the atmosphere in almost that precise proportion. While Cavendish described clearly this method of producing nitric acid from air, his observations passed almost unnoticed until in 1892 Sir William Crookes showed that the same result could be attained by the use of the electric arc. A little over 20 years ago two American chemists, working at Niagara Falls, made the first attempt to produce nitric acid by this method on a commercial scale, but they were not successful. Simultaneously two Norwegians, Birkeland and Eyde, at Christiania constructed a furnace in which they produced a gigantic arc through which air was blown. Their apparatus proved to be satisfactory and economical, and in the first decade of this century a great industry sprang up in Norway under the direction of these investigators.

It is well known that by a comparatively simple device, the electric arc playing between two terminals may be spread out into a circular or disc-like sheet, and in the Birkeland-Eyde furnace as now operated this is about 8 feet in diameter. A single furnace of this kind consumes about 5000 H.P., which would be sufficient to supply 5,300 of the old arc lamps such were used to light the streets of Toronto before the present system was adopted. Only about 3 or 4 per cent. of the electrical energy supplied is actually utilized, so that it is only possible to carry on this process where electric power is produced at a very low cost.

Through this gigantic sheet of flame, at a temperature of approximately 3000° C., air is blown, and a chemical combination manifests itself by the appearance of a brown colour in the air which emerges. Only 1 per cent. of the nitrogen at best is transformed, which emphasizes the comparative inefficiency of the process. The brownish-coloured air is conducted to immense towers built of granite where it is washed with water, the brown portion, known to chemists as nitric oxide, dissolving in water to form nitric acid. By boiling down or concentrating this dilute solution, ordinary strong nitric acid may be produced, but since this can only be transported and stored in glass vessels, not much of this acid is actually produced. By allowing the weak or dilute

acid to act upon limestone calcium nitrate results, and this, after the removal of the water, is a white substance readily shipped in bags. The final product of the arc process as operated in Norway is calcium nitrate, and in this substance Chile nitre has found its first serious competitor.

In this connection it is interesting to note that at the present time a factory using the arc process on a small scale is about to commence operations at Merritton, Ont., with an estimated output of 850 tons of nitric acid per annum. The process, as has already been mentioned, can only succeed where electric power is cheap, and this opens up some interesting possibilities in a country such as ours.

Having now seen how it is possible to make nitric acid from air by one process, let us turn to one of the other two by which the same goal may be reached.

In 1892 Willson discovered that if limestone and coal were heated together in an electric furnace, a substance was formed which, on the addition of water gave off acetylene. This was calcium carbide, consisting of the elements Ca and C, and the possibility of producing conveniently in any locality with simple equipment such an excellent illuminating gas as acetylene led to a very rapid growth in the manufacture of carbide. Without referring further to the manifold uses of acetylene, I must pass on at once to a further discovery. It was found early in this century that if nitrogen be passed over calcium carbide while hot, a new substance was formed which contained nitrogen in addition to calcium and carbon, and to which the name calcium cyanamide was given. This substance is itself a fertilizer though not so valuable as the nitrates, and it was with a view to manufacturing cyanamide fertilizer that the American Cyanamide Co. built a factory at Niagara Falls, Ont., in 1909 with a capacity of 60,000 tons per annum.

If calcium cyanamide be boiled with water under suitable conditions ammonia is produced and, as we shall see later, nitric acid can be prepared readily from the latter. During the Great War most of the cyanamide produced at Niagara Falls was shipped to New Jersey, where it was converted into ammonia, united with nitric acid to form ammonium nitrate and then used as the chief constituent in high explosive shells.

Just shortly before the War a German chemist, Haber, succeeded in bringing about the union of nitrogen and hydrogen by heating these gases to about 550° C. under heavy pressure. By means of catalyst, metallic iron with a little molybdenum, and using the high pressure of 3000 lb. per sq. in., he was able in 1905 to cause a mixture of nitrogen and hydrogen—which was quite inert at ordinary temperature and pressure—to unite to form ammonia to the extent of 17.5%, although in practice this figure is reduced to about 6%.

The process was taken up by the giant of the German Chemical Industry, the Badische Anilin and Soda Fabrik in 1910, and by

1914 a factory had been built at Oppau with a capacity of 25 tons of ammonia per day. When it is recalled that the working temperature is about 500° C., just barely below a dull red heat, and that the pressure is 3000 lb. per sq. in., the engineering problem of constructing the apparatus may be understood. Ordinary steel loses a great deal of its strength at such a temperature, and in addition was found to be attacked by the reacting gases, so that it was necessary to employ some of the new alloy steels which have only recently been discovered. The bombs in which the purified nitrogen and hydrogen are passed over the catalyst were, at Oppau, 39 feet high, 31 in. external diam., and 7 in. thick in the wall. The heating is done electrically within the bomb, and in this way the outer walls may be kept at a lower temperature. After passing over that catalyst the gases are washed with water, which dissolves the ammonia, and the residue is returned to the system. By 1918 Germany had two factories working the Haber process and producing 620 tons of ammonia per day from the nitrogen of the air and the hydrogen of water.

In 1918 a French engineer, Claude, who had already to his credit the invention of an excellent machine for liquefying air, announced that he had improved the Haber process by raising the working pressure to 15,000 lb. per sq. in. Claude has constructed and is operating a plant in France in which he employs this enormous pressure, the great advantage of which lies in the fact that the piping and catalyst bombs are of small size compared with those of the Haber process. Claude process plants are operating, or are being built, at fourpoints in France, and one factory is under construction in each of the following countries: Belgium, Spain, Switzerland, Italy and Japan.

An Italian engineer, Casale, has produced another type of synthetic ammonia apparatus, and two factories of his design are at work in Italy, another is under construction at Niagara Falls, N.Y. Italy has four factories for the synthetical production of ammonia, and the absence of coal in that country has involved the importation of all the ammonia required by the industries until the present time.

When mixed with the proper proportion of air or oxygen and passed over a catalyst, platinum or oxide of iron, heated to about 750° C., ammonia is burned or oxidi ed to form the same brown gas nitric oxide which comes from the arc furnaces. On dissolving this gas in water nitric acid is formed, and consequently it is a comparatively simple step to pass from ammonia to the acid which we are discussing.

However we may secure a supply of ammonia we are at the same time assuring ourselves of a corresponding quantity of nitric acid, and this serves to explain the great efforts put forth in Germany to make ammonia from nitrogen and hydrogen. During a war the supplies of Chile nitrate might be cut off, as actually happened, and being deprived of nitric acid Germany would have been unable to produce explosives. With the Haber process

carried on within her own boundaries any shortage of nitric acid was impossible, and the enormous development in the Haber factories during the war testified to their importance. One must, however, bear in mind the fact that cyanamide plants were at work in Germany for some time before the War, and consequently an independent supply of ammonia or nitric acid was available.

It is particularly worthy of note that in the arc process, and in the catalytic processes for making nitric acid, only nitrogen, oxygen and hydrogen are necessary, the two former obtainable from air and the latter from water, the only other requisite being electric energy.

Where coal is lacking and electric power is fairly abundant, as in Ontario, either of these processes are capable of being worked, and it strikes one as a curious contrast that the energy in a water fall, in some rocky and inhospitable district of our north land, may be utilized to produce the nitrate required to maintain the fertility of the broad plains of the West. It is not at all unlikely that we shall see before long such a plant erected, and it is quite conceivable that the production of sodium or ammonium nitrate may be one of the new industries to spring into life in those parts of Canada which have known hitherto only the Indian and the trapper.

STEAM ACCUMULATORS AS A FACTOR IN POWER COSTS

*By Alfred J. T. Taylor, A.S.M.E., Toronto

Invention of Dr. Johannes Ruths Permits Supply of Steam at Any Time and Quantity, Canadian Combustion Expert Claims, in Emphasizing the Quality it Effects in the Products of a Plant

Widely fluctuating loads in a boiler plant do more to adversely affect economy than possibly any single influence. In Canada very few exact investigations have been made of the influence that the variations in the rate of production and consumption of steam or power exercise on the working methods, and the overall efficiency obtained in industrial plants. On the contrary, the heat balances of such plants have invariably been set down, as if the source of energy to be used on the one hand, and the consumers of energy on the other, were delivering and absorbing energy at a constant rate without any variations. In practice these variations have been accepted as unavoidable, and attempts have been made to counteract their effects by forcing the boilers, which causes considerable losses, owing to the fact that the supply of heat on the one hand, and the consumption of steam or power on the other, are by no means equivalent in quantity nor coincident in time.

Storing Steam in Water

There is, however, a principle of storing steam in water under increasing pressure and discharging it under falling pressure that provides an excellent means for avoiding the evil effects of fluctuating demands for steam, and virtually places the consumers of energy or heat independent of the rate of supply from the boiler.

A steam accumulator, invented by Dr. Johannes Ruths, of Sweden, and in use in Scandinavia and other countries on the continent of Europe, more than seventy such devices being found in the pulp and paper industry alone, merits the attention of the English-speaking world.

The accumulation of steam in water and its subsequent evaporation is a well-known principle, and has for a long time past been used by practical engineers; in this connection reference may be made, for instance, to the Rateau accumulators and the feed water accumulators of Druitt Halpin and others. The direct storage of steam without water has also been effected in practice, both in containers of constant volume and in containers of variable volume.

Stores up Exhaust

In all cases just mentioned, however, with the exception of feed-water storage systems, the definite aim in view is that of

*From a paper before Local branch of the A.S.M.E.

accumulating the exhaust steam of hoisting engines, or rolling-mill engines, etc., where the work proceeds intermittently, so as to make it possible to pass the exhaust steam from these engines into continuously working low pressure turbines, even during the intervals when the main engines are at rest.

Every steam boiler of very large water content could in principle be arranged as an accumulator, but, in order that the boiler may act as an equalizer, it must be constructed for a pressure above the normal working pressure, so that variations between the maximum and the normal working pressure may be obtained.

The fact that no such increased pressure has been provided for, but that, on the contrary, boilers are usually constructed for a pressure only so much higher than the steam pressure needed as corresponds to the pressure drop in the pipe lines, proves that the principle referred to has never been carried through completely in practice.

Keeping Pressure Constant

Instead of aiming at accumulation by permitting variations of pressure, efforts were and are still, on the contrary, directed towards keeping the pressure as constant as possible. It is usually considered as evidence of good working if the boiler pressure diagrams approximate as closely as possible to straight lines.

As, with constant boiler pressure, no accumulator action is possible, it follows that the quantity of heat conveyed from the fire to the heating surface per unit of time must likewise exactly correspond to the amount of steam that the boiler is required to supply. It is, therefore, evident that the variations in the steam demand must cause corresponding variations in the fuel supply to the boiler.

The only correct solution of the problem of rational steam utilization is to employ the steam boiler exclusively as the steam generating agent, working at a constant load, and to dispense entirely with the use of the boiler as an accumulator.

Needs Little Water Space

Accordingly, the steam generator may be built with very small water space, or even with none at all—in the latest constructions the steam generator is, practically speaking, simply a coiled pipe—and should be worked at an absolutely constant high pressure. Instead of every common type of boiler, at present having its own water tank, which, consequently, must be built to stand the full boiler pressure, the water spaces of all the individual boilers should be, so to say, united into one tank, entirely separated from the boilers and well insulated against loss of heat.

In such tanks, usually built for pressures lower than those of the boilers, a much larger variation of pressure is attainable than in the boilers. Furthermore, these tanks can be built of any size whatever, irrespective of the type of boilers used or of the size of their heating surface.

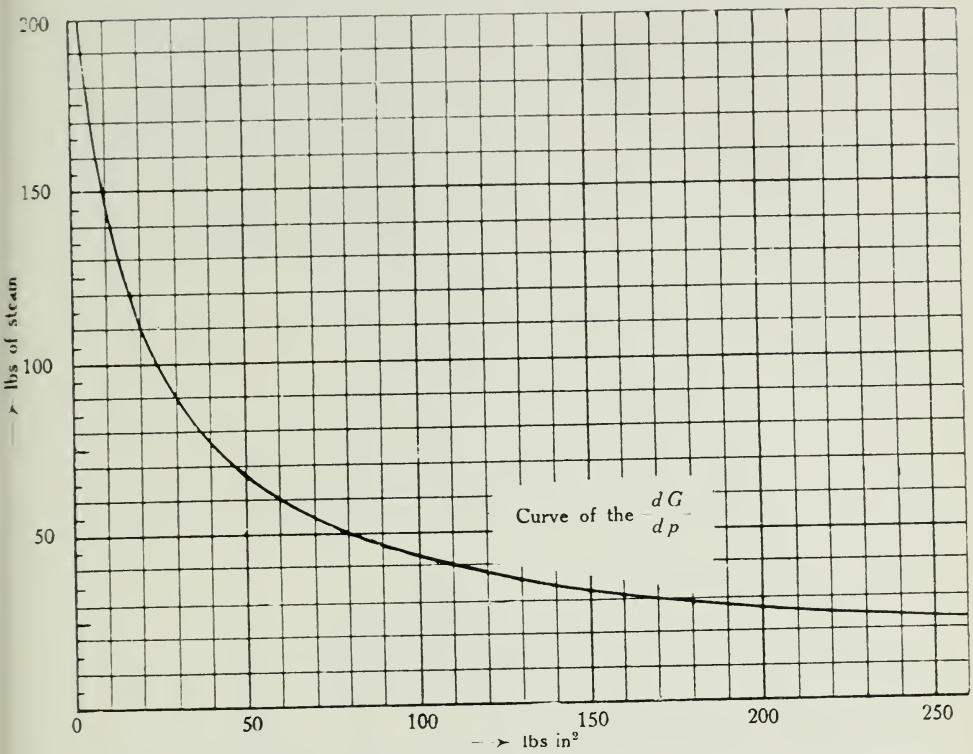


Fig. 1.—The amount of steam G. produced by 100 ft.³ of water through a drop of pressure 10 lbs./ins.² for various steam pressure p.

In order to illustrate the importance and scope of this idea, an analogy from a different invention may be cited. The writer refers to the success obtained by Ilgner in the equalization of load and supply in power plants by separating the energy storing flywheel from the main engine and driving the former by a separate engine.

In this way, Ilgner succeeded in overcoming great variations of short duration in the rate of power consumption of certain types of machinery, such as rolling mills, hoisting plants in mines, etc., which variations it had not previously been possible to overcome by the use of flywheels arranged in the usual way.

Eliminates Variations

This same principle has been applied by Dr. Ruths to the production and use of steam, and he has thereby succeeded in eliminating all variations in the rate of supply as well as in the consumption of steam.

In the same way as Ilgner separated the flywheel from the main engine, Dr. Ruths has separated the water space from the boiler, and has a separate container, in which the steam is accumu-

lated or stored under pressure. By this means the mass of accumulating water working in the steam system representing a large "flywheel effect" can be increased to any desired extent.

As it is not necessary that the accumulator should be built to stand the high pressure of the boilers, full use can be made of the property of hot water to accumulate much more steam at low than high pressure for a given pressure drop.

The importance of this may be clearly seen from Fig. 1, in which the amount of steam produced per unit of volume (or 100 cu. ft.) of boiling water for a certain pressure drop (or 10 lbs. per sq. in.) is shown for various steam pressures.

It must also be observed that the accumulator, when separated from the boiler, can be so arranged that a very much greater pressure-range may be permitted in it than is possible in a boiler.

Dr. Ruths, when he approached the subject of steam accumulation, did not confine himself merely to the saving of exhaust steam, as Rateau and other engineers had done, but set himself the problem of overhauling the entire heat and power economy of industry, from the point of view of the accumulation of steam in water.

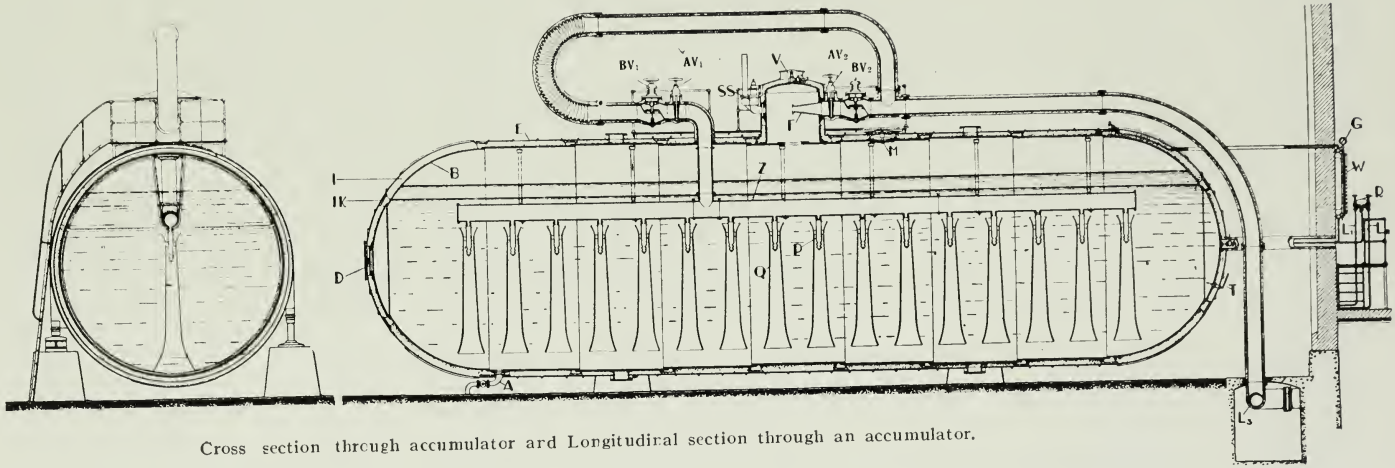
Little Study of Variation

A survey of the literature on this subject shows that the conditions affecting this general question have not been fully recognized, so that there was not only the task of solving the problem to be done, but first of all to work out a clear and definite formulation of it. That this was necessary is conclusively proved by the fact that the number of cases is very small in which the variation of energy, especially heat energy, in the various branches of industry have been systematically studied.

In research work extending over many years in the great variety of industries, the author has executed a large number of measurements of the rate of steam consumption. Out of the results of that work the problem of general steam accumulation was formulated and its subsequent solution evolved.

Ruths' accumulators are built in the form of cylindrical steel tanks with hemispherical ends. They are filled with water up to 90-95 per cent. of their capacity. Fig. 2 shows a sectional view of an accumulator. B is the vessel constructed of riveted steel plates. I is a covering of non-conducting material, usually consisting of up to four inches of infusorial earth (kieselguhr) or infusorial earth mixed with cork, or of a magnesia composition. J-K are insulation blocks covering the riveted seams of the shell. They are made movable, so as to enable the inspection of the seams to be readily carried out. The lagging is protected by a sheet iron cover, E.

The accumulators are equipped with the fittings usual in boiler practice, and further with arrangements for the charging and discharging of the steam, two non-return valves BV_1 and BV_2. BV_1



Cross section through accumulator ard Longitudiral section through an accumulator.

admits charging steam to the internal steam distribution pipe Z, and the charging nozzles P, which are equipped with the circulation pipes Q to insure a uniform heating of the water. Through valve BV_2 the discharge of steam takes place. Fig. 3 shows a typical installation.

Heat Losses Low

The heat losses of the accumulators are considerably less than is generally imagined, as a matter of fact so small that they are of no practical consequence. Result of insulation tests made on accumulators in practice show that with the thickness generally adopted, the heat losses only correspond to from 0.1 to 0.5 per cent. of the coal consumption of the boilers, and are, therefore, of little importance.

That being so, the accumulators are usually erected in the open air, and often at some distance from the boiler-house, in factory yards, etc.

From this description it is evident that such an accumulator, although it can be charged with superheated as well as with saturated steam, can only deliver saturated steam. In certain cases, however, it is desirable to have an accumulator that can also deliver superheated steam. This is of great value, especially in plants where the accumulator has to feed such consumers as steam engines, steam turbines, steam hammers, etc., which utilize the energy of steam for the production of motive power.

The possibility of feeding such consumers with superheated steam means a considerably lower steam consumption and hence a reduction in the accumulator capacity needed.

Add Second Container

This problem has been solved by adding to the steam accumulator a second container, so designed that it works on the same principle as the Siemens regenerative heater used in connection with metallurgical furnaces for pre-heating the gas and the air of combustion.

The accumulator for superheated steam thus consists of two separate containers, one for storing the superheat, and one for the storage of the latent heat of the steam.

Special Uses for Accumulator

Apart from the general value which a steam accumulator has in the numerous plants where there are variations in the demand of steam for heating or for power purposes, or where there are variations in the supply of heat (surplus gas, waste heat, etc.) an accumulator can be used in connection with power transmission systems, *e.g.*, those utilizing water power.

The combination of a steam accumulator with one or more steam turbines is a useful means of maintaining a local stand-by working with small no-load costs and other working expenses.

Even in cases of sudden interruptions in the supply of current from long-distance power transmission systems the local load can, if required, be taken over without any delay by a steam turbo-generator, fed by the accumulator, without the necessity of keeping the boilers permanently under steam. The steam accumulator will in such cases take the place of lead batteries.

Further, in industries such as iron and steel works, where a co-equalization has to be maintained between the variation in the supply of energy (surplus gas from blast furnaces and coke ovens, waste heat from furnaces and engines) and the fluctuations in the consumption of energy for power purposes, the steam accumulator is of more commercial and technical value than expensive Ilgner type plants and the storing of low-grade blast furnace gas in gasometers.

It is interesting to note in the latter connection that one pound of steam which, when stored in a steam accumulator, occupies .02 of a cubic foot, corresponds in thermal value to about 16 cubic feet of blast furnace gas.

Results Obtained

The working of the manufacturing plant and power plant is rendered independent of the working of the boiler plant.

In a factory or power station equipped with an accumulator, steam can be supplied at any time at an unlimited rate, should it be required in manufacturing operations, or through peak loads in the power distribution system.

For example, a heating process normally consuming steam at the rate shown by Curve I in Fig. 4 (which rate is dependent on the steam supply from the boilers) can be intensified by accumulated steam to the high rate shown by Curve 2, whereby the time (T-t) is saved.

By having a steam supply which is unrestricted, although the boiler load may be constant, costs for installing or extending manufacturing apparatus or boiler plant are materially reduced by the more intensified use of the existing installation.

Uniform Product

Lack of steam often occurs in factories just when an increased supply of steam is badly needed for carrying through a manufacturing process. The process is then delayed or the quality of the product lowered.

It must be borne in mind that as a rule, of two operations proceeding simultaneously, the cruder process, such as "heating-up," etc., will generally use steam to the detriment of the more refined operations, like drying or chemical processes.

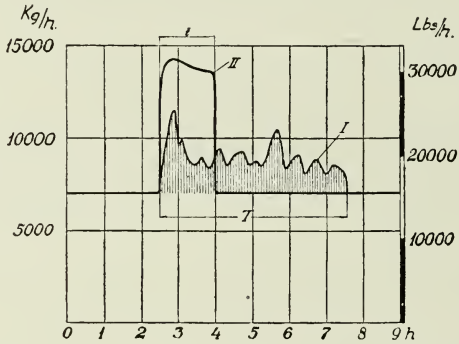
By impediments of this kind the conduct of the manufacture, from the point of view of obtaining high quality, is rendered more difficult, and, as a matter of fact, irregularities of this nature in the steam supply to the individual apparatus are frequently the cause of the production of so-called "second-class qualities."

By the adoption of an accumulator, different processes can be conducted independently of one another, and with something like laboratory exactitude.

Consumption of Fuel

By the action of a steam accumulator the peak-loads are taken off the boilers and their pressures kept constant. Fires can be closely adjusted to give the most favourable combustion of the fuel, economy resulting, together with more even working and less wear and tear.

An accumulator furnishes the possibility of keeping the boiler pressure constant, and just below the blow-off pressure of the safety valves, which fact has a favourable influence on the output of back-pressure turbines or engines.



Reduction in time required to get up steam in a factory after installation of an accumulator. Curve 1—Diagram before installation of an accumulator; Curve II—with accumulator.

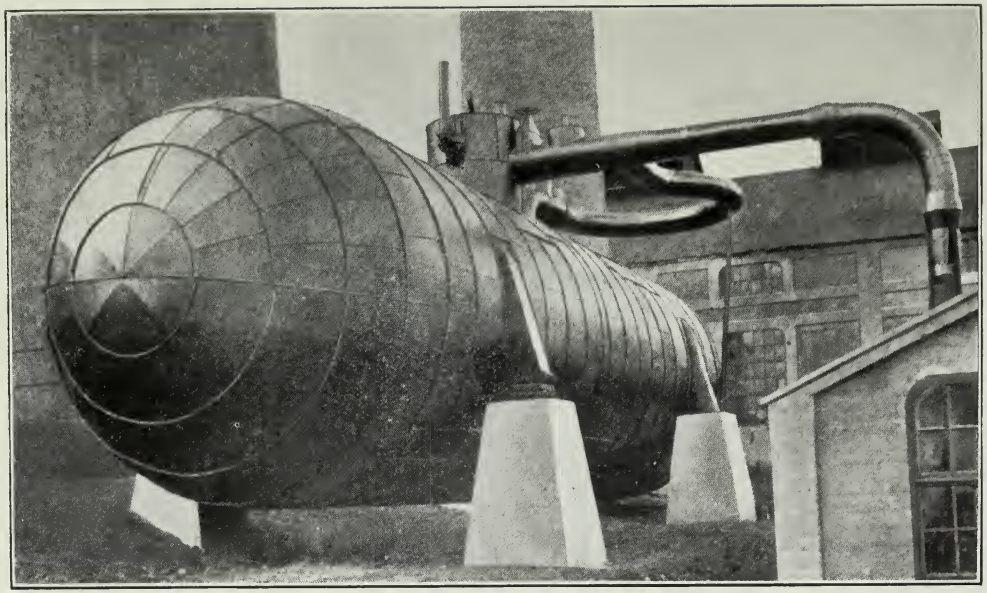
Moreover, the output of the high pressure stage of an extraction turbine or of a simple back-pressure turbine is materially increased by the equalizing influence of the accumulator, as with the constant steam flow from the boilers through the turbine, very small losses occur in potential energy of the steam by throttling.

If a back-pressure extraction-power system does not comprise an accumulator, and the fluctuating steam flow to the consumers is as usual led through the back-pressure turbine or the high-pressure stage of the extraction turbine, it must be run at a variable load and consequently great throttling losses result.

Gain in Turbine Output

The action of the accumulator effects a further gain in the output of such a turbine from the fact that, despite all the variations in the steam demand, practically all the steam produced by the boilers is conveyed through the turbine.

It often occurs in such plants, when not provided with an



Accumulator in the Kvarnsveden Paper Mills of the Stora Kopperbergs Bergslags A.B., at Kvarnsveden near Borlänge (Sweden). Capacity 6350 ft., length 51.5 ft., diameter 13.1 ft., accumulating capacity 17600 lbs. of steam.

accumulator, that large quantities of heating-steam have to be by-passed direct from the boilers without power generation, as it is seldom of advantage economically to make the turbine of such a size that it can pass the maximum demands of heating-steam which occur, for instance, only when digesters are started, dyeing vats are heated up, etc.

Even in the case of a steam power plant, from which no steam is abstracted or exhausted for heating purposes, as, for instance, in an ordinary power station, there is no loss of power by the insertion of an accumulator, eventually arranged for super-heated steam, between two turbine stages.

Boiler Pressure Constant

As the boiler pressure as well as the super-heat are automatically kept at maximum values by the accumulator, and as, further, the efficiency of the high-pressure stage is practically constant, though the accumulator pressure varies, and as also the low-pressure stage —especially if it is equipped with automatic nozzle control—utilizes the steam from the accumulator without extra losses, the total heat drop available is not less with an accumulator introduced between two turbine stages than it would be without it.

At most, the heat drop is reduced by an amount corresponding to the extra back-pressure caused by the water-head above the nozzles in the accumulator. This head, however, is small, so that the loss entailed is of no practical importance.

This subject is far too wide in theory and application to be dealt with in one article in Power House. There is, in the writer's opinion, no single advance in steam generation during the past ten years that means so much to the heat-using industries as the accumulator.

PROTECTIVE LEGISLATION

*By Professor H. E. T. Haultain

Professor Haultain said in part: I feel very genuinely that it is an honour to address the Engineering Society and it is also a very definite pleasure. I seize this opportunity to again congratulate you as a society. Sir Robert Falconer has said on more than one occasion that the Engineering Society represents what is best in student activities and Sir Robert doesn't say that sort of thing without meaning it. It is not alone for what you do that you are recognized, but it is also for what you stand. In time of difficulty we know where the Engineering Society will be; on the side of what is right and decent and reasonable. You are to be congratulated on your leaders, on your ability to pick the right men for leaders and what, perhaps, is even more important, to follow them when you have picked them. It is a splendid manifestation of the old tribal spirit. The Engineering Society is one of the fine things that School owes to John Galbraith. He organized the Society about 39 years ago, and for the first three years was its President and then handed that office to the students. I have never been prouder of anything than that I was the first student President of this Society 36 years ago, and now I come to you as President of the Association of Professional Engineers of Ontario, and I am glad indeed that my first appearance in this office should be before you.

Now in regard to this legislation for Engineers. It is an old subject which has been taken up at intervals for many years. Twenty-five years ago the Canadian Society of Civil Engineers made an effort to obtain the necessary Dominion legislation and failed. Quebec and Manitoba succeeded in obtaining special legislation, but it was of very little effect. Six years ago the Engineering Institute of Canada called a conference of representatives from all parts of the Dominion with instructions to sit in conference in Montreal until they had unanimously approved of a draft Bill that might be presented in each province of the Dominion. They held twenty-one sessions and after much compromise drew up a Bill which is the foundation of present day legislation in seven of the provinces. This legislation has been termed Protective Legislation, and what do we mean by that term? In the first place it must mean protection for the public, the public must be guarded from inefficient work. Everybody sees that in the case of the Doctors, people must not be allowed to place their lives in the hands of a man who is not properly qualified for the work. How often are the public called upon to entrust their lives to the Engineers? The life of the ordinary man depends upon the Engineer far oftener than on the Doctor. Think it over. In the second place protective legislation should mean

*Address before Society, Feb. 11, 1925.

protection from unfair competition for the Engineers themselves. There are many who consider the latter a more important phase. Personally, the protection of the public is, to my mind, the much more important phase. By far the larger majority of Engineers need no protective legislation. They do need, however, the status and recognition by the public which such legislation would help to promote.

There are, at least, four divisions of Engineering organization. First, the student organization, such as you have here. Second, that organization which stands as a guardian of the profession, concerns itself with professional ethics and stands for all that is best in the profession. Of this class we have the Institution of Civil Engineers in England, the father of them all, and the Engineering Institute of Canada. Third, there is the organization concerned more with the exchange and dissemination of technical information and ideas, not concerning itself with professional ethics, concerning itself more with the industry than with the profession, for example, The Canadian Institute of Mining and Metallurgy. Fourth, the recently formed Association of Professional Engineers in each province, whose main function is the obtaining of suitable legislative enactments. A few years ago most of us thought that such legislation was impossible, mainly because you cannot define Engineering. You cannot say where Engineering begins and the work of the capable artisan ends, but that notable conference in Montreal six years ago showed us the way. Ontario took that draft Bill and proceeded to get together representatives of the Civils and Mechanicals and Electricals, Miners, Chemicals and Architects in an effort to get unanimity of opinions. It took two years of patient work, during which the Architects dropped out of the scheme. Finally a Bill was tentatively approved of, but before it left the committee stage it was assailed from many angles, even by some of the Engineers themselves. It is due to the dogged perseverance of a small group, of whom, let me say plainly I was not one, though I was on the side lines, that a much altered Bill was passed. It was apparently so weakened that most Engineers said it was worse than useless. The only thing that it protected was the use of the term "Professional Engineer," but this has proved to be of great educational value, not only to the public, but to the Engineers themselves. It also gives us the power to discipline our members and to compel the giving of evidence under oath. Some provinces obtained legislation which nominally made ours a closed profession like Medicine, but enforcing the act has been difficult if not impossible in some districts. We have a good illustration of that in the O.T.A. Personally, I am glad we started off as we did. It is now up to us to get more legislation, and before we can get this we must carry on an intensive campaign of education of ourselves and of the public and of the politician, and this educational work will do us as much good as, possibly more than, will the ultimate legislation. In Quebec, however, they revised their old act three or

four years ago and the new form is very stringent and well-established and they have succeeded in making it stick. Recently they caused a man to be fined $300 and costs for a breach of the Act and as a result of that one case they have settled 44 cases out of Court.

In all this education of the public there is something else, our old friend the tribal spirit. If we can get people to realize that here is a group of men who stand for what is decent, and will not stand for what is not decent, it will mean more to the profession than any legislation we could get through. What the profession needs more than anything else is to create and maintain the same tribal spirit which the Engineering Society has here. Lately a good many of us have been thinking that the transition the graduate goes through is too sudden. You are turned out to shift for yourselves in a world which has not much interest in you, and by the time you find your feet the old spirit of tribal loyalty has all but disappeared. What are you fellows going to do to help you take your tribal spirit out into the field? Look around the whole world to-day and you will find that there is no movement without an organization and propaganda. Every branch of Engineering has its organization and there are a thousand and one other organizations in Toronto alone. Here you men are supported on all sides by an organization. You have the Faculty and you have the Engineering Society, both of which you lose suddenly when you graduate. What does the E.I.C. do for you? What does the C.I.M.M. do for you? You may join as student members but how much does that really mean? It would appear as if the young graduates were without an organization and without propaganda. Think it over.

PRESENTATION TO THE SOCIETY BY J. ALLAN ROSS OF THE COMPLETE REPORTS OF THE GREGORY COMMISSION IN MEMORY OF J. WALTER FRANCIS

On March the 4th a complete set of all the reports of the recent Hydro Enquiry Commission, generally known as the Gregory Commission, was presented to the Engineering Society by Mr. J. Allan Ross, in memory of Walter Francis. Mr. Ross had been a member of this Commission and had preserved his files complete in every respect covering all the reports made to the Commission and by the Commission to the Government. There are not more than six such complete sets in existence. It is without question the most extensive and the most complete Report on any Engineering project that has ever been made, and is a model of the very highest order of what a Report should be.

Mr. Francis was Consulting Engineer to the Commission and under his direction, aided by a staff of more than 60, data concerning all the Engineering, economic and historical details of the entire work of the Hydro-Electric Commission in Ontario was compiled. The gathering of this material required some 23 months and the total cost involved in the work of the Enquiry Commission and the preparation of the Report was in the neighbourhood of half a million dollars, and the works reported on involved an expenditure of two hundred and fifty million dollars. This work was finally completed only a short time before the death of Mr. Francis, and there is no doubt that the tremendous effort that he expended in perfecting this Report in every detail hastened his death.

The Report occupies about 8 feet of shelf. It is proposed that it shall be housed in the University Library under the control of the Librarian in a special case with a suitably engraved plate.

A number of members of the Society had gathered to receive the presentation, and were addressed by Mr. T. H. Hogg, Hydraulic Engineer to the Hydro-Electric and President of the Engineering Alumni Association. Mr. Hogg said, in part:

"It was the duty of Mr. Francis to collect all the engineering and financial data in connection with this investigation. The Power Commission was more or less on trial. He handled it most diplomatically; of course he was a School man, and many of the officials of the Commission were School men. That may have accounted for his intense sympathy and the courteous manner in which he approached various members of the Commission. You will understand that with one side on the defence and the other looking for the truth you are liable to get into difficulties. Some of the members were not very sympathetic. It is due principally to Mr. Francis and to two members of the Investigating Com-

mission, Mr. Ross, an old graduate, and Mr. J. Allan Ross, who has made this presentation to you, that this report could not be any fairer than it is.

". . . It was Mr. Francis' and Mr. Ross' idea that this report should be published; however, when the new government came in they found finances in such a terrific state that they could not find the funds. It would have entailed a very large amount of money. There could not have been a more courteous act than that of Mr. Ross in handing this report to the Engineering Society for their own records, and perhaps the most courteous feature of the presentation is the mention of the name of Walter J. Francis.

"Mr. Francis, as you know, was a very young man when he died; fifty or fifty-two. He was just at the height of his powers. When we are close to a man we sometimes don't appreciate him; I think we didn't appreciate Francis properly. To my mind he was one of the greatest men who has graduated from the Faculty of Applied Science and Engineering. His greatness came perhaps not so much from his ability as a constructing engineer . . . but is really in the human aspect of the man. He was the most human man that I ever ran up against. Nothing was too much trouble for him. While this report was being compiled he was doing many other things. He was President of the Alumni of the Faculty of Applied Science, President of the Engineering Institute of Canada, Vice-President of the Corporation of Professional Engineers of Quebec; a member of the American Society of Civil Engineers and of the Institute of Civil Engineers of Great Britain; a charter member of the Institute of Consulting Engineers; a life member of the Engineering Society of the University; a member of the Montreal Board of Trade, of the Rotary Club, the University Club and the National Club. He was interested in the Boy Scout and Wolf Cub movements, being President of the Montreal Boy Scouts. He was Secretary of the Shriners Hospital for Crippled Children of Montreal; he was a great Mason. He gave to every organization that he went into the best that was in him. That is the reason I would class him as a great engineer and graduate of this faculty.

"Many of our graduates are very selfish. All we think of is the accomplishment of something which will stand as a credit to ourselves from a professional viewpoint. What we should try to do is to secure a little more of comfort to the ordinary individual, and I think that Francis has done more of that than any of us can ever hope to do. That is why the name of Walter Francis will go down in history."

The following is a letter received from Mr. J. Allan Ross.

Gentlemen:

I regret very much that I will not be able to accept your kind invitation for Wednesday afternoon.

May I take this opportunity of writing a few words about our mutual friend, the late Walter J. Francis?

It has been well said that men make the University. Bricks form merely the outward signs—that the history of a University is the history of the achievements of its men. Walter J. Francis, whose intense life was brought to a close last year at the height of his powers, was one of those outstanding men who have helped to place the University of Toronto among the foremost universities on this continent.

Mr. Francis was a distinguished engineer. His life of intense work very clearly determined his high calibre.

When the Hydro-Electric Inquiry Commission was appointed by the then Provincial Government to investigate all phases of Hydro development in Ontario, the engineer member of this Commission, Dr. R. A. Ross, was insistent that Walter Francis was the best equipped man in Canada to undertake the engineering section of that Inquiry.

The result of two years of intensive labour, covering a most thorough investigation of all engineering features of the Hydro enterprise, unquestionably hastened Mr. Francis' death, but the report on Hydro, which he had just completed, now stands forth in the opinion of foremost electrical engineers as the finest report of its kind ever produced anywhere. Walter Francis, in his achievements, touched life at fundamental points. He was, as you all know, much more than an engineer. He believed in the humanities, as was evidenced by his Presidency of the Montreal Rotary Club, and countless public services. He was a man engaged in big, elemental things. His is the type of School of Science graduate who constitutes the very background of the Institution.

As Arthur D. Little says, writing in the *Atlantic Monthly*, about the membership of the National Academy of Sciences: "They have recast civilization through their study and application of the great fundamental facts of nature and the laws of her operation."

If we stop a moment to consider we realize that engineers are recasting civilization every day. Francis was such an engineer. Gaby, Acres, Hogg, and others are also of this type.

It is a privilege to present to the University of Toronto my Hydro-Electric Inquiry Commission library, which, in the main, is a complete endorsation of our great Provincial Hydro development, and, as a report, is worthy of careful study by every student who is interested in the engineering, financial, and governmental relations of the Hydro development in Ontario.

Yours sincerely,

ALLAN ROSS.

SUDDEN SHORT CIRCUIT PHENOMENA IN A.C. SYSTEMS

By Arthur H. Frampton

Prize Essay in Competition of the Toronto Section of A.I.E.E.

1. Introduction

The tremendous growth of the modern generation and transmission system has rendered of vital importance the adequate protection of the system against damage due to short circuits, etc. Continuous and reliable service is contingent upon the proper selective action of relays, and the subsequent behaviour of the circuit-breakers operated by such relays.

In order to intelligently attack the problem of providing this protection, an accurate knowledge must first be gained as to the possible magnitude and character of the transient disturbance, to be dealt with under the condition of short circuit. It is the purpose of this paper to, first, outline the factors which may effect the magnitude and character of this transient disturbance second, describe a few of the more general schemes used to study the disturbance which may obtain on any particular installation.

2. Short Circuit Phenomena

(A) *Factors Affecting Short Circuit.*

It may be stated that the magnitude and character of the transient disturbance, which will occur when short circuit occurs on a system, will be affected by the following factors:

1. The total K.v.a., reactance, and transient characteristics of the synchronous machinery connected to the system.
2. The K.v.a., arrangement, resistance, reactance, and capacitance of all reactors and transformers through which power can be supplied to the point of short circuit.
3. Number, resistance, reactance, capacitance, and arrangement of all circuits over which power can be supplied to the point of short circuit.
4. Contact resistance at the short circuit.
5. The nature of the short circuit, whether single phase or three phase.
6. The K.v.a. and power factor of the load being carried at the time of the short circuit.
7. The point of the pressure wave at which short circuit was established.
8. The use of automatic voltage regulators.

It is the general practice to assume a value for certain of these factors, such that the conditions obtaining at s.c. will be the worst possible, as these must be provided for in any event. The contact resistance is therefore assumed as zero; the s.c. is taken as involving all three phases; the load being carried is assumed as 100% at a power factor of .8, and the s.c. as being established at that point

on the pressure wave which gives maximum possible instantaneous current. The effect of voltage regulators is usually neglected.

With the value of these factors assumed we need only consider the effect, then, of the synchronous machinery, the transformers and reactors, and the circuits over which power may be supplied. It is very common practice to simplify the problem still further, by neglecting the effect of resistance and capacitance, and considering only the effect of the reactance of the apparatus involved.

(B) *Short Circuit of Synchronous Machines*

While other factors may influence the *magnitude* of the s.c. current in any system the *character of the transient wave* is governed almost exclusively by the synchronous machinery connected to the system. This machinery may be in use as alternators supplying the line load, as synchronous condensers floating idly on the line, or as synchronous motors supplying mechanical power, but the characteristic of delivering large values of current when suddenly short circuited is common to all. This very large value of current, occurring immediately at s.c., is known to decrease to a very much smaller value in a short time after s.c. occurs. The general shape of this transient is given in Fig. 1. In this particular case, the s.c. occurred as the current wave was approaching zero, from the negative alternation. The *initial* rush of current is represented by CA. This initial value is limited by what is known as the "armature reactance," or the "inherent reactance," of the machine.

FIG. 1.

GENERATOR CHARACTERISTICS.

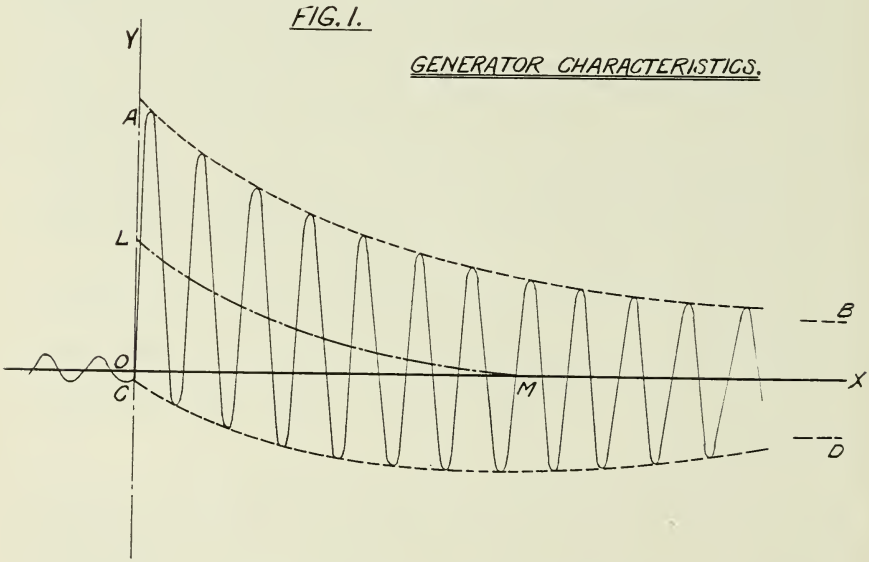


Illustration of behaviour of generator current when short-circuited from full load at 0·8 power factor

This reactance, while spoken of broadly as "armature reactance," should include the combined self-inductance of both the armature and field circuits, as is shown by Messrs. R. E. Doherty and O. E. Shirley in their paper published in the 1918 edition of the Transactions of the Institute.

The transient current then decreases along the familiar logarithmic curve, till it reaches a sustained value represented by the limits BD. This value is reached in approximately 2 seconds, though the time is placed by some writers as low as 0.8 seconds, and by some as high as 3 seconds. The magnitude of the sustained current is limited by what is known as the "synchronous reactance" of the alternator, and the sustained value is reached when the field flux and the opposing flux of armature reaction reach a stage of equilibrium.

This value of synchronous reactance (or impedance, if resistance is not neglected) is readily obtained by the familiar "s.c. impedance" test. The alternator is short circuited and the field strength increased until full load current flows in the armature. The armature circuit is then opened, and the open circuit voltage is measured. Dividing this open circuit voltage by the rated load current gives the synchronous impedance in ohms. For ease in calculation, this voltage is often expressed as a percentage of the rated voltage, and the value so obtained is termed the "percent. impedance" of the machine. Given this value for any machine, the s.c. current is obtained, as a multiple of rated current, by the quotient 100 divided by the per cent. impedance.

Because of the fact that the true inherent, or "transient," reactance of the machine is not readily measurable, the value of the initial current is usually determined by subjecting the particular machine to an actual s.c. test, and measuring the current by means of an oscillograph. Several methods have been advanced for calculating this reactance, or for determining the value of the initial current, from the design data of the machine, but each method adopts some assumed value for the effect of the field self-inductance and is therefore open to criticism. However, certain of these methods, particularly that advanced by Messrs. Doherty and Shirley in the A.I.E.E. Transactions, 1918, obtain very close checks between the calculated values and those obtained by actual test. The value of the transient reactance can be expressed in the form of a percentage in exactly the same form as the synchronous impedance.

The current wave obtaining at s.c. may, or may not, be symmetrical about the zero line. If s.c. takes place when the voltage is at a crest value the current wave will be symmetrical, but if the voltage is at zero, the initial rush will be totally offset to one side or other of the zero line. The degree of offset may also vary anywhere between these limits depending on the point at which s.c. occurs, but, in any case, the alternating wave will be of the same amplitude.

If the wave is offset it means that a d.c. component is present,

in addition to the a.c. wave. This d.c. component, represented by L.M. in Fig. 1, disappears in approximately 0.15 to 0.25 seconds, and the wave becomes symmetrical. It is this fully offset value of the initial current which must be allowed for in designing the synchronous machine, and its value is usually taken at 1.8 times the symmetrical value.

(C) *Transformers*

We have seen that it is the characteristic of synchronous machines to deliver large values of current upon s.c. If a transformer is included between the machine and the point of s.c., the transformer acts merely as a series impedance, limiting the magnitude of the transient current.

The value of this impedance (or reactance, if the resistance is again neglected) is determined by the well-known s.c. impedance test. The secondary is short circuited, and the voltage is raised upon the primary until full load current flows. The "equivalent impedance" of the whole transformer is then, this impressed voltage, divided by the current flowing. As before, the percentage this voltage is of the rated voltage is a very convenient expression for use in calculations of the total impedance, or reactance, of a system, and this "percent. impedance" is the expression usually given.

Suppose a transformer is rated as having 5% impedance. This means that 5% rated voltage will cause full load current under s.c., or, that rated voltage will cause 100 divided by 5, or 20 times full load current.

(D) *Protective Reactances*

In practically all modern installations the use of protective reactances, or current limiting reactors, is standard practice. These reactances are included in the network at strategic points, usually in generator leads, between bus sections, or in power feeders, in order to limit the current at s.c. by providing additional series impedance.

This reactance, while it may be expressed in ohms, is also more conveniently expressed as a percentage, in precisely the same manner as above. It is usually expressed as a percentage of the rated voltage drop that is caused by a certain current flowing through it. This current is often taken as that which would flow when a 10,000 K.v.a. load is being drawn through the reactor; but if the reactor is connected in the leads of a generator, it is more often full load current on that generator.

(E) *Cables and Transmission Lines*

It is readily seen that the only possible effect of any length of cable or transmission line included between the power supply and the point of s.c. is to limit the flow of current to the fault.

In considering the effect of the cable, due regard must be paid to the cable resistance, as well as its reactance. The reactance,

which in this case includes capacity reactance, as well as inductive reactance, is more nearly comparable to the resistance in the cable and cannot therefore be neglected. However, cables are seldom of sufficient length to offer any serious impedance to the current on s.c. and will not be further considered here.

The effect of the transmission line, unless of extreme length or of iron wire, can again be said to be a function of its reactance only. This reactance can be readily calculated in ohms (per mile of line, say) by several well-known methods, when the size of conductor, spacing and frequency of the line is known. To comply with the previous cases, this reactance is expressed as a percentage, by the percentage of rated volts drop that it causes, when some specific load is being carried. The usual practice is to specify 10,000 k.v.a. as the load, even though line has only a fraction of this capacity.

Having now considered the effect of each of the component parts of a generation and transmission system upon the transient s.c. phenomena, let us now consider a few of the more general means of determining the magnitude of that disturbance, selecting a number of typical installations to illustrate the principles involved.

3. Short Circuits on Power Systems

(A) *Calculation of Short Circuit Currents*

With power systems of the capacity and intricacy of the present day, it is extremely impracticable to actually apply short circuits to the system, in order to study the nature of the resultant transient phenomena. However, such data is, in the majority of cases, obtainable by methods of calculation, to within a very fair degree of accuracy.

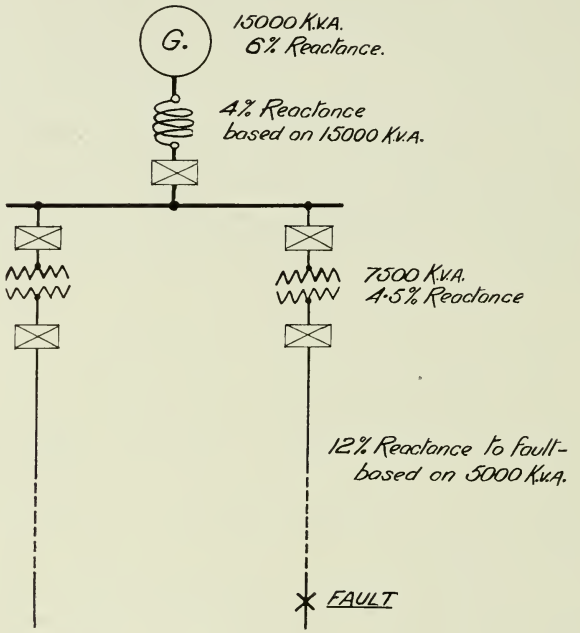
In practically all such calculations the effect of resistance and capacitance is neglected, and only the reactance of the circuits is taken into account. In general, the errors so introduced are of negligible importance, and are on the safe side in any event. This reduces the calculations to applications, more or less difficult, of Ohm's and Kirchoff's laws, using reactance in place of resistance. To illustrate the methods, two simple cases will be assumed, and the calculations carried through for each. (See Problems).

In this calculation it is the value of synchronous impedance or reactance that is assumed for the generator, and hence 600 amps. represents the sustained s.c. current. If the inherent reactance had been used, the initial current would have been obtained, but this value would not have been a great deal higher than 600 amps., due to the limiting effect of the remainder of the system.

A very useful method of approximating this s.c. current, at varying intervals after s.c. occurs, is given by Messrs. Hewlett Mahoney and Burnham in the A.I.E.E. Transactions, 1918. A standard generator characteristic has been decided upon, after careful experimentation, and a series of curves are based upon it. The calculation of the total per cent. reactance of the system is

made exactly as above, and then the value of the transient current, at any instant after s.c. occurs, may be read directly from the curves as a multiple of the rated load current. Problem 2 illustrates the method.

PROBLEM #1.



The given values of reactance are first reduced to a common base, say, generator capacity, 15,000 K.v.a.

Reactance of generator	6.0
" " reactor	4.0
" " transformers	9.0
" " line	36.0
Total reactance to fault	55.0%

Then K.v.a. at point of s.c. $= \frac{15{,}000 \times 100}{55}$

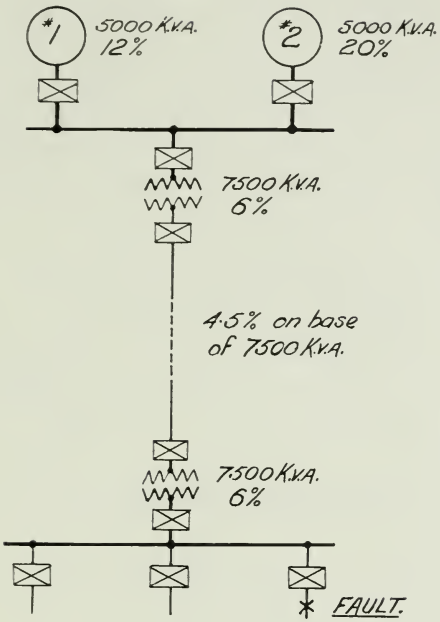
$= 27{,}300$

If line voltage be 26,000 volts

Short circuit current in line $= \frac{27{,}300 \times 1{,}000}{26{,}000 \times 1.73}$

$= 600$ amperes.

PROBLEM #2.



Reduce reactances to total 10,000 K.v.a. base.

Generator No. 1	24.0
" No. 2	40.0
Transformer	8.0
Line	6.0
Transformer	8.0
Reactance of generators in parallel	15%
Then total reactance to fault	37%

From given curves, reading along line of 37% total reactance we find that after 0.1 secs. (say)

current = 2.8 times rated load current.

$$\text{Therefore, short-circuit current} = \frac{2.8 \times \text{Gen. capacity} \times 1000}{1.73 \times \text{line voltage}}$$

$$= \frac{2.8 \times 10{,}000 \times 1{,}000}{1.73 \times 44{,}000}$$

$$= 367 \text{ amps.}$$

Similarly for any other time interval.

(B) *Experimental Determination of s.c. Currents*

With the complicated networks of modern systems, particularly where several separate sources of power are inter-connected, the methods of calculation are extremely lengthy, and, in most cases, not practical. Test methods have therefore been devised, which give much quicker results, of sufficient accuracy for routine short circuit determinations.

The most obvious test method is that in which all the essential elements in the system under consideration are reproduced in a miniature system in true proportion. This kind of test is essentially a miniature a.c. system. To build such a system is an expensive proposition, and the data required is not usually of sufficient importance to justify the expenditure. Several power companies have constructed them, however, one of which, built by the Telluride Power Co., of Provo, Utah, is described by Mr. G. H. Gray in the Institute Transactions, 1917. The General Engineering Laboratory of the General Electric Co. has constructed a somewhat similar miniature system, which has adjustable values of resistance, inductance, and capacitance, so that almost any system may be represented, for purposes of studying s.c. problems.

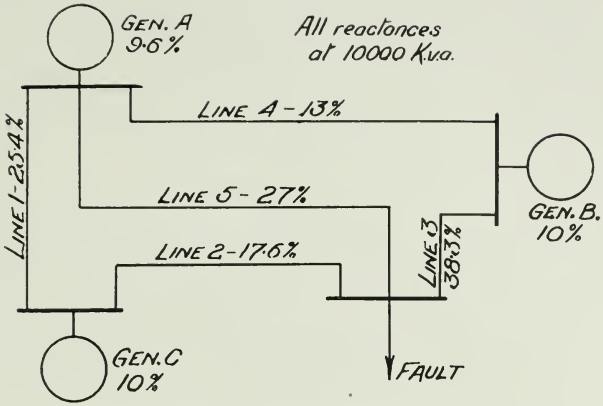
The method has the very great advantage, in that, not only current densities, but also directions of power flow, and phase relations of current and voltage, may be determined by its use. It is particularly valuable in studying phase-to-phase shorts, and wire-to-neutral shorts on grounded neutral systems, problems which cannot be accurately solved by any other means.

The chief disadvantages, other than the expense involved, are the necessity for both resistor and reactor units, and the limitations of low-range a.c. instruments. The miniature apparatus must be either of relatively large current rating to accommodate available instruments, or delicate low-range meters must be provided.

(C) *Short-Circuit Calculating Table*

By far the commonest experimental device used in the treatment of these problems is that commonly known as the "short-circuit calculating table." In this device the three-phase constants of each particular sector of the system are converted to a single-phase equivalent, and that value is represented, to some chosen scale, by a single resistor unit. The whole power system is, in this manner, represented by a single line network of resistor units. A direct current voltage may then be impressed on the composite circuits, at the actual source of power under consideration in the system, and the value of the s.c. currents readily determined by direct observation.

Two general methods are adopted for representing the circuit constants; in the one the per cent. reactance only is considered, and in the other the total per cent. impedance is used. The former method gives very fair results, except on systems which include, either very long transmission lines, or groups of parallel feeders in which the impedance angles of the various feeders differ greatly. In all cases, however, the error is on the right side, giving higher values than the miniature a.c. system. The latter method is particularly suited to systems having parallel connected circuit elements of widely dissimilar impedance angles, but the errors which appear are on the low side, and so are to be avoided. These two general schemes are very fully discussed by O. R. Schurig in his paper "The Experimental Determination of Short-Circuit



TYPICAL SYSTEM LAYOUT

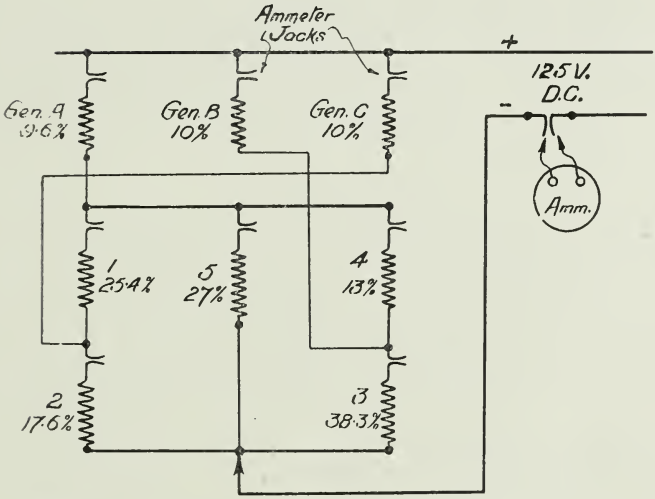


FIG. 2. REPRESENTATIVE SET-UP ON CALCULATING TABLE.

Currents in Electric Power Networks," published in the A.I.E.E. Transactions, 1923.

By reason of the fact that single phase equivalents are used for the calculating table, it can only be used in a consideration of short-circuits involving all three phases. This is not a great objection, however, as the values so obtained are those generally used in the selection of oil circuit-breakers. The method is used extensively, and tables are constructed to represent particular systems, or, more often in fact, they are built with variable resistor units, so that various settings may be used, for predetermining plant and system layouts.

A typical layout, and its representative set-up on the calculating table, is shown in Fig. 2. When the d.c. potential is applied, currents will flow in the network proportional to the actual s.c. currents, and so, knowing the scales employed, the actual values may be readily calculated. In the latest boards, the plugging is done with telephone jacks and cords, making a very compact arrangement, and the junction points are looped through telegraph keys within reach of the operator, so that any required current is obtained by simply pressing the proper key.

4. Conclusion

In a paper of such limited length, as this must of necessity be, the detailed treatment of this subject is obviously impossible. However, several particularly interesting articles are listed in the bibliography, which cover all phases of the subject under discussion. In closing, we would refer the interested reader to these articles, wherein he may discover for himself such further information as he may desire.

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THE HYDRO POWER RESOURCES OF NORTHERN ONTARIO AND THEIR RELATIONSHIP TO THE MINERAL AND PULPWOOD RESOURCES OF THE DISTRICT

Thesis by T. M. Patterson

I. Introductory.

It is intended in the course of this thesis to consider the hydro power situation in a specified area of Northern Ontario and its relation to the development of the mineral and the pulpwood resources of the district. The limits of the above-mentioned area are outlined in the following section and thereafter follows a note on the bases of estimates used, a concise *résumé* of the power rivers in the district, a review of the available power and of the developed power in these rivers, a note on the relationship of this available power to the developed power, the relationship of water power resources of the area to the mining district, the relationship of water power resources of the area to the pulp and paper industry and, finally, the general conclusions.

II. Area Considered.

The southern portion of the area considered takes in all the north shore drainage into Lakes Superior and Huron from the Magpie River on the west to the French River on the east, inclusive. Furthermore, it includes the Ottawa River drainage from Mattawa town to Quinze Lake. The northern portion consists entirely of the Moose River drainage basin. A more comprehensive conception of the territory involved may be obtained by referring to the accompanying Plates I and II. In Plate I the area considered is hatched in red and throughout the thesis this hatched portion will be known as the "Area."

The Height of Land divides the "Area" into two main watersheds: one draining to the north, the other to the south. The northerly basin consists of a long slope which may be conveniently divided into three reaches: the upper, which contains many lakes and has a comparatively gentle slope; the central, in the upper part of which the slope increases considerably, while further down it becomes quite precipitous; and the lower, which flattens out towards James Bay. The watershed is triangular in shape, the base extending along the Height of Land and the apex being at the mouth of the Moose River. The southerly slope, which drains into the Great Lakes system, is short and its rivers tortuous.

Included in the "Area" are numerous rivers containing large amounts of available power, for the most part undeveloped, rich gold, silver, nickel and iron mining areas and vast stretches of pulpwood forests. Large areas of good agricultural land are found in the Clay Belt of the northern slope.

Roughly speaking, there are included in the "Area" some seventy-five thousand square miles of forests, rocky mining country, lakes and rivers but nowhere is native coal found. This fact adds appreciably to the value of the abundant supply of undeveloped hydro-electric power to be found in the district.

III. Basis of Estimates[1].

Basis of power data.

The power data contained in this thesis are based upon rapids, falls and power sites of which the actual existent drop or the head possible of concentration is definitely known or at least well established. It is reasonable to assume that in such a relatively unexplored section as the "Area" there are various rapids and falls of greater or lesser power capacity not as yet recorded, and which will only become available for tabulation as more detailed survey work is undertaken and completed. Furthermore, no consideration has been given to the power concentrations which are feasible on rivers or portions thereof of gradual slope where economic heads may be created by means of power dams, excepting only at such points as definite studies have been carried out and the results thereof recorded.

Basis of run-off data.

The run-off data are based upon stream measurements made by the Ontario Hydro-Electric Power Commission prior to 1919 and by the Dominion Water Power Branch subsequently. For the Quinze River in the Province of Quebec, which has been included because power developed therein is being transmitted to the Ontario mining areas, the stream measurement data are based upon the records of the Federal Department of Public Works. In some rivers daily records are available for several years, while on others only intermittent records have been secured. Knowing the area in square miles above the gauging station and striking the average discharge figure at this station over a number of years, the run-off per square mile of the watershed above the station may be readily calculated and applied to the areas above the various power sites.

Basis of "Ordinary Minimum Flow" and of "Ordinary Six-Month Flow."

For the sake of uniformity, it is considered desirable to develop

the water power estimates on certain definite bases. Two of these as developed by the Dominion Water Power Branch and used throughout this thesis are "Ordinary minimum flow" and "Ordinary six-month flow."

The "Ordinary minimum flow" is determined by taking the averages of the minimum flow for the lowest two consecutive seven-day periods in each year, over the period for which records are available at any particular station. The "Ordinary six-month flow" is based upon the continuous power indicated by the flow of the stream for six months of the year. To actually determine this flow the months of each year are arranged according to the day of lowest flow in each. The lowest of the six high months is then taken as the basic month, and the average flow of the lowest seven consecutive days in this month determines the maximum for that year. The average of such maxima over the period for which records are available gives the required figure.

Basis of Power Estimates.

The power estimates have been calculated on the basis of 24-hour power at 80% efficiency for conditions of "Ordinary minimum flow" and "Ordinary six-month flow."

IV. Power Rivers.

In the treatment of the power rivers of the "Area" it is intended to touch on the general description, water supply, run-off records, developed storage, undeveloped storage, developed power and undeveloped power. Where these headings have been omitted it should be understood that no definite information is available. In view of the limited permissible length of this thesis and of the extensive field which it endeavours to cover, this section must necessarily be brief. Accordingly, for the sake of brevity, as much general information as possible is given in the next succeeding paragraph, which applies to all or most of the rivers.

The larger part of the "Area" is included in what is termed as the pre-Cambrian shield, a broad "U"-shaped belt of pre-Cambrian rock which stretches around Hudson Bay from Labrador to the Arctic Ocean. A smaller portion in the vicinity of James Bay is composed of Devonian rock. From this it will be seen that the geology through which the different rivers flow is much the same. The rivers flowing southward are tortuous, while those flowing northward have more commonly long stretches of quietly flowing water. The run-off data is based on the records of the Ontario Hydro-Electric Power Commission previous to October, 1919, when the Dominion Water Power Branch took over this work; and since 1919 this data has been based on the records of the latter organization.

Due to the excellent pondage areas above most of the power plants in the district, only minor ice troubles have been experienced.

Available power at the individual sites will be found in Table A appended hereto. Reference should also be made to Plate II. The sites listed, both developed and undeveloped, have been numbered consecutively, beginning with the River Magpie on the southern slope and proceeding eastward and the Missinaibi River on the northern slope and proceeding eastward.

Below is given a brief outline of each river, in order of its respective importance:

Montreal River and Tributaries.

General Description.—The Montreal river is one of the most important tributaries to the Ottawa river drainage and lies largely in the District of Temiskaming. The more important tributaries, ascending the river, are Lady Evelyn River, Spring Creek, Bear River, Sydney Creek and the East and West branches. These feeders all rise in the western and southern lakes of the basin, some being fed in part by springs.

Water Supply.—The drainage area of the Montreal River is 2,575 square miles, exclusive of Lake Timagami, which is now completely diverted for power purposes to the Sturgeon River. The average annual recorded precipitation on this area over a 10-year period was 29.82 inches. Extreme winter conditions ordinarily cause a water shortage in January and February.

Developed Storage.—The storage possibilities are as yet very incompletely utilized, only a relatively few lakes being under control. The actual number controlled is 8 and the total capacity of these is 4.58 billion cubic feet or 105,100 acre feet.

Undeveloped Storage.—There are 11 possible storage lakes in the watershed which have not been developed. The total storage capacity of these lakes is estimated at 5.70 billion cubic feet, or 130,500 acre feet.

Developed Power.—There are several important hydraulic plants in the basin amongst which might be especially mentioned the three pioneer developments of the Northern Ontario Light & Power Co., Ltd., all situated on the lower reaches of the main river. The total hydraulic power installed in the watershed from Table III is 19,190 horse-power.

Undeveloped Power.—Numerous sites in this district remain undeveloped, some of considerable consequence. The total undeveloped power is 23,583 horse-power for six-month development.

Spanish River.

General Description.—The Spanish River, with its tributaries, the Aux Sables and Vermilion Rivers, is an extremely valuable

source of developed and potential power. It is the largest tributary to Lake Huron west of the French River.

Water Supply.—The total area drained by the Spanish River is approximately 5,250 square miles. The watershed, especially in the headwater, possesses a large number of lake expansions. The average yearly run-off for the area over a 6-year period was 18.13 inches.

Developed Storage.—The developed storage in the watershed is sufficient to meet all present demands. Seven lakes are regulated and the International Nickel Co. has a large pondage dam on the river above its plant. The total storage capacity developed is 27.43 billion cubic feet or 629,900 acre feet.

Undeveloped Storage.—The total additional lake area in this watershed, on which it is estimated storage could be developed, is 22,500 acres.

Developed Power.—The total developed power on the Spanish River and its tributaries as taken from Table 3, is 48,020 horsepower.

Undeveloped Power.—There still remains undeveloped a total of 24,110 horse-power based on "Ordinary minimum flow" and 56,180 based on "Ordinary six-month flow."

Abitibi River and Tributaries.

General Description.—The Abitibi is one of the three most important tributaries to Moose River and, together with its tributaries the Black and Frederick House Rivers, comprises almost the entire eastern portion of the Moose River drainage. From the outlet of Lake Abitibi, where the river heads, to its mouth, it has a total length of 228 miles.

Water Supply.—The total area of the Abitibi basin is approximately 11,920 square miles. Records taken at the easterly end of Abitibi Lake over a 27-year period give an average annual precipitation of 26.80 inches. Records at the Iroquois Falls station over a 9-year period give an average of 32.14 inches while the average annual precipitation over 11 years at Cochrane is 25.57 inches.

Developed Storage.—Lake Abitibi is used for artificial storage by the Abitibi Power & Paper Co. in connection with its plants at Twin Falls and Iroquois Falls. Using a storage depth of 6½ feet the reservoir capacity is 52 billion cubic feet or 1,200,000 acre feet.

Undeveloped Storage.—It has been proposed that by building a dam at the head of a small chute 6 miles below Frederick House Lake on the river of the same name, a working storage head of 12 feet could be obtained. This on the lake area of 15 square miles would give a storage capacity of 5.02 billion cubic feet or 115,200 acre feet.

Developed Power.—There are three important developments on the Abitibi, two located on the upper portion of the river, and used for pulp and paper manufacture, and the third on the middle reach

of the river which is now being completed to supply power to the Porcupine mining area. The total installed power on the river, including the new development, is 76,000 horse-power.

The only other development in the watershed is that at Monteith, where the Ontario Government Experimental Farm has developed 35 horse-power on the Driftwood River.

Undeveloped Power.—There are 18 undeveloped water-power sites in the basin, with a total available horse-power of 181,550 at "Ordinary minimum flow" and 291,569 at "Ordinary six-month flow." Nine of these sites are on the Abitibi proper and have available horse-power of 176,128 and 277,017 at the above two flows respectively. The remaining undeveloped power is divided up between the Frederick House and Black Rivers and tributaries.

Mattagami River and Tributaries.

General Description.—The Mattagami River is one of the most important tributaries of the Moose River, the latter being formed by the junction of the Mattagami and Missinaibi. The river heads in a fairly extensive system of lakes just north of the height of land, and has a total length of some 240 miles in which it descends over 1,000 feet. It has two main tributaries, the Groundhog and Kapuskasing Rivers, which enter from the west.

Water Supply.—The total drainage area of the Mattagami and tributaries is 14,306 square miles.

The total annual precipitation for 1920 at two different stations in the district was 26.71 inches and 15.90 inches respectively, but as 1920 was a year of very low precipitation this should probably be increased to obtain the average annual figure.

Developed Storage.—The Northern Canada Power, Limited, operates five storage reservoirs in the upper Mattagami basin. These five constitute the total regulation in this watershed with total storage capacity of 12.82 billion cubic feet or 294,720 acre feet.

Undeveloped Storage.—Very little definite information is available concerning the storage possibilities which appear to exist on this river. It is estimated that the Kapuskasing and Red Pine Lakes and the Kapuskasing River could be regulated to give a total storage capacity of 2.17 billion cubic feet or 49,800 acre feet.

Developed Power.—Two thousand nine hundred horse-power are developed on the Kapuskasing and its tributary the Kebwaska; while 37,150 horse-power are developed on the Mattagami River proper. This gives a total of 40,050 developed horse-power for the watershed.

Undeveloped Power.—There are 11 undeveloped sites on the Mattagami, with available power of 113,640 horse-power at "Ordinary minimum flow" and 220,110 horse-power at "Ordinary six-month flow"; 2 on the Groundhog with available power of 2,162 and 5,500 horse-power at these flows; 7 on the Kapuskasing totalling

6,126 horse-power and 14,235 horse-power and one on the Trout River, a tributary to the Kapuskasing, with 304 and 714 horse-power at the above-mentioned flows. Thus there is a grand total of 122, 232 horse-power at "Ordinary minimum flow" and 240,559 horse-power at "Ordinary six-month flow" in the watershed, which is as yet undeveloped.

Missinaibi River and Tributaries.

General Description.—The Missinaibi is one of the three main tributaries to the Moose River, the latter being formed by the junction of this river and the Mattagami. The stream heads in Missinaibi Lake near the Height of Land, and in its total length of 244 miles descends some 1,050 feet. The river's main tributary, the Opasatika, joins it in its lower section.

Water Supply.—The total drainage area of the Missinaibi is 9,368 square miles, including the 2,010 square miles drained by the Opasatika. There are no precipitation stations in this district and those nearby have not records over a sufficient period to establish an average annual figure.

Undeveloped Power.—Information regarding falls and rapids is not very complete especially on the tributaries. However, the river offers several possibilities, some of which seem to be particularly attractive. The total undeveloped water-power in this watershed as shown in Table A in the appendix hereto, is estimated at 12,648 horse-power at "Ordinary minimum flow" and 28,094 horse-power at "Ordinary six-month flow."

Sturgeon River.

General Description.—The Sturgeon River is the largest feeder of Lake Nipissing. It is 140 miles long and enters the lake from the north where it drains a large area dotted with streams and lakes of various sizes.

Water Supply.—The Sturgeon River drainage area is 2,676 square miles in extent, a considerable portion of which is lake surface. Approximately one-third of this area is occupied by the Timagami River basin which is tributary to the Sturgeon. The mean annual precipitation in the area is taken as 29.82 inches, this being the average of 10 years observations at Montreal River.

Developed Storage.—Considerable regulation is carried on in the lakes of this basin under the control for the most part of the Spanish River Pulp and Paper Mills, Ltd. The capacity of the 11 lakes regulated is 25.97 billion cubic feet or 596,700 acre feet.

Undeveloped Storage.—So far as is known, no large undeveloped storage sites exist in the watershed, although it is possible to create storage on some of the smaller lakes, of which there are several. It is also possible to raise many of the existing dams and

increase the present working storage depths.

Developed Power.—The Spanish River Pulp and Paper Mills, Ltd., has installations amounting to 18,590 horse-power on this river in connection with the company's mills at Sturgeon Falls.

Undeveloped Power.—There are thirteen known undeveloped sites in the Sturgeon watershed, of which eleven are on the main stream and two on its tributary, the Timagami. It is estimated that these sites, if developed, could supply 8,266 horse-power at "Ordinary minimum flow" and 15,403 horse-power at "Ordinary six-month flow."

Blanche River and Tributaries.

General Description.—The Blanche River drains a considerable agricultural territory west of the River Quinze and enters the north end of Lake Temiskaming through four outlets.

Water Supply.—The drainage area of the Blanche River is approximately 2,000 square miles. An average annual precipitation of 29.73 inches recorded at Haileybury over a 20-year period may be considered as applicable to this district.

Developed Storage.—Storage is at present being maintained on two lakes on the east and west branches of the river respectively. The total storage capacity of these reservoirs is 1.97 billion cubic feet or 45,100 acre feet.

Undeveloped Storage.—There are several good-sized lakes and a large number of small ones in the watershed which could be utilized for storage. The possible draught on these lakes is not known but the total surface area of eleven of them is some 18,800 acres.

Developed Power.—Power installations in the Blanche watershed total 2,710 horse-power.

Undeveloped Power.—At a total of 19 undeveloped sites it is estimated there is 6,833 horse-power at "Ordinary minimum flow" and 14,848 at "Ordinary six-month flow."

Upper Ottawa River.

General Description.—The upper Ottawa basin above the head of Lake Temiskaming comprises an area of some 9,700 square miles.

Water Supply.—The water supply is derived chiefly from forest-covered Laurentian country interspersed with a great many lakes. Precipitation records indicate for the upper basin an average annual precipitation of about 32 inches.

Developed Storage.—The total storage capacity of the three lakes regulated in this district is 113.38 billion cubic feet or 2,604,-800 acre feet.

Undeveloped Storage.—There are a large number of lakes in

the watershed which might be utilized for storage. Thirteen of these would provide a storage capacity of 98.58 billion cubic feet or 2,263,680 acre feet.

Developed Power.—Within the limits of the "Area" considered herein there is one development of 20,000 horse-power on that portion of the Ottawa known as the Quinze River.

Undeveloped Power.—At 4 undeveloped sites there is estimated to be a total of 95,900 horse-power at "Ordinary minimum flow" and 198,010 at "Ordinary six-month flow."

South River.

General Description.—The South River is a small but valuable power stream in the district of Parry Sound, flowing northwest into Lake Nipissing.

Water Supply.—The drainage area of the South River is 350 square miles. Records of precipitation at the Montreal River Meteorological station are applicable here and over a 10-year period give an average annual precipitation of 28.13 inches.

Developed Storage.—The Ontario Hydro-Electric Power Commission controls storage on 7 lakes with an existing combined capacity of 23,400 acre feet, or 1.02 billion cubic feet.

Undeveloped Storage.—There are very few known undeveloped storage sites that are of value.

Developed Power.—Installations totalling 3,975 horse-power are installed on the South River and tributaries.

Undeveloped Power.—It is estimated that at a total of 6 sites 1,129 horse-power could be developed at "Ordinary minimum flow" and 3,059 horse-power at "Ordinary six-month flow."

French River and Tributaries.

General Description.—The French River flows into Georgian Bay and is one of the main contributors to the St. Lawrence system. It is joined at its mouth by the Wanapitei River.

Water Supply.—The drainage area of the French River is 7,377 square miles including the Wanapitei basin. The mean annual precipitation in the watershed, over a 10-year period, has been estimated at 29.82 inches.

Developed Storage.—Storage capacity being operated on the Wanapitei River amounts to 21.6 billion cubic feet or 496,000 acre feet.

Undeveloped Storage.—Owing to possible interference of navigation on the French River, storage on this river for power purposes has not been allowed.

Developed Power.—There is a total turbine capacity of 9,900 horse-power installed at 2 sites on the Wanapitei River.

Undeveloped Power.—There is a total undeveloped power on

the French and Wanapitei Rivers of 21,415 horse-power at "Ordinary minimum flow" and 37,849 at "Ordinary six-month flow."

Mississagi River.

General Description.—The Mississagi River drains southward into Lake Huron. The approximate area of the watershed is 3,717 square miles.

Water Supply.—The average annual precipitation is approximately 30 inches.

Undeveloped Power.—There are 17 undeveloped sites on the river. It is estimated that these would provide 31,486 horse-power at "Ordinary minimum flow" and 66,089 horse-power at "Ordinary six-month flow."

Matabitchuan River.

General Description.—The Matabitchuan River drains into Lake Temiskaming within a few yards of the Montreal River.

Water Supply.—The drainage area of the Matabitchuan is 363 square miles containing many moderately-sized lakes. The average annual rainfall for the area is placed at 29.82 inches.

Developed Storage.—There is a total storage capacity of 6.51 billion cubic feet or 149,600 acre feet developed in this basin.

Undeveloped Storage.—There are additional lakes in the basin on which storage could be developed but figures for the capacity of these are lacking.

Developed Power.—The Northern Ontario Light & Power Co. have a turbine installation of 11,000 horse-power on this river.

Mattawa and Amable du Fond Rivers.

General Description.—The Mattawa, together with the flow from its tributary the Amable du Fond, enters the Ottawa River at the village of Mattawa.

Water Supply.—This watershed covers 880 square miles. Records over a 10-year period show an average annual precipitation of 32.88 inches.

Developed Storage.—A total storage capacity of 1.64 billion cubic feet or 37,800 acre feet is developed in this basin.

Undeveloped Storage.—Storage to the amount of 14.93 billion cubic feet or 342,600 acre feet is available but undeveloped in the watershed.

Developed Power.—Two hundred and eighty-six horse-power are installed near Mattawa.

Undeveloped Power.—There is a total of 4,465 horse-power at "Ordinary minimum flow" and 9,714 at "Ordinary six-month flow" undeveloped in the watershed.

Michipicoten and Magpie Rivers.

General Description.—The Michipicoten, with a drainage area of 2,008 square miles, is joined near its mouth by the Magpie River, with a drainage area of 718 square miles, and the two together flow into Lake Superior.

Water Supply.—The average annual precipitation is approximately 31.0 inches.

Undeveloped Storage.—Storage is feasible on Dog Lake to the extent of 4.46 billion cubic feet or 102,400 acre feet.

Developed Power.—Turbine installations on these rivers total 4,200 horse-power.

Undeveloped Power.—Undeveloped power is available to the extent of 8,793 horse-power at "Ordinary minimum flow" and 30,-302 at "ordinary six-month flow."

Montreal, Agawa, Batchawana, Sand, Chippawa and Goulais Rivers.

General Description.—These are all comparatively small streams and are north shore tributaries to Lake Superior at its eastern end.

Water Supply.—The total area of their drainage basins is approximately 3,075 square miles. A study of precipitation records in adjacent territory indicates that an average annual precipitation of 30 inches may be expected.

Undeveloped Storage.—It is estimated that storage to the amount of 5.57 billion cubic feet or 128,000 acre feet can be obtained on the Montreal River.

Undeveloped Power.—There is a total of 8,363 horse-power at "Ordinary minimum flow" and 29,962 at "ordinary six-month flow" undeveloped on these various rivers. For individual rivers and sites see Table A in the Appendix.

Whitefish River.

General Description.—This river, which is really a series of lakes, enters Lake Huron at the Bay of Islands.

Water Supply.—The total drainage area of the river is 360 square miles, of which much is lake area. The average annual precipitation is approximately 31 inches.

Undeveloped Power.—There are 4 undeveloped sites on the river, totalling 961 horse-power at "Ordinary minimum flow" and 2,303 horse-power at "Ordinary six-month flow."

V. Available Power in the "Area."

Probably the most direct method of presenting in concrete form the *total available power resources* of the "Area" under natural conditions is by means of a table. This will necessitate an estimate

of the power available under natural conditions at the present developed sites deduced on the same basis as the estimates of the power available at the undeveloped sites are deduced in the preceding section of this thesis. For example, at plant No. 57 on the Spanish River, the Huronian Co., Ltd., has an installation of 20,600 h.p., but the power available calculated for "Ordinary minimum flow" and "Ordinary six-month flow" is 7,913 h.p. and 12,464 h.p. respectively.

A complete compilation of the available power will be found in Table A[3] appended hereto. In this table are recorded for each individual power site, its name (if named), its location, the head in feet, the ordinary minimum and the ordinary six-month flow and corresponding power, as well as any special comments as to development, etc. On account of its length, it has been inserted at the end of this thesis as an appendix. A summary follows hereunder in Table No. 1:

From this table it is found that the available power in the "Area" reaches the surprising totals of 727,591 h.p. for "Ordinary minimum flow" and 1,360,189 h.p. for "Ordinary six-month flow." The Abitibi River, with 335,946 h.p., the Mattagami, with 242,170 h.p., and the Quinze (in Quebec), with 176,010 h.p. available, together make up more than one-half the total for "Ordinary six-month flow." The figure given in the table for the St. Mary's River comprises only one-half the total power available on the river. The other half belongs to the United States. It will be seen by examining Plate I, in conjunction with Table 1, that the power is fairly well distributed over the "Area."

VI. Developed Power in the "Area."

In turning to the matter of developed power in the "Area," it is proposed in this section to treat only of the *general* phases, since the relationship of the developed power to the mining and pulp and paper industries will be dealt with in greater detail in subsequent sections.

The developed power may be analysed on different bases, firstly, as to type of development, secondly, as to location or distribution, and thirdly, as to ownership.

(1) *Development of Hydro Power.*

During the year 1923 the total hydraulic power installation of Canada was increased by over a quarter of a million horse-power, and at the beginning of the present year (1924) had reached the imposing total of 3,227,414 h.p.[4] The growth of installed power in the "Area" may best be realized by means of a table. Table No. 2 hereunder shows the growth by years since 1890.[5]

TABLE NO. 1—AVAILABLE POWER IN SPECIFIED AREA OF NORTHERN ONTARIO (BY RIVERS)

River	Tributary to	Available H.P. Ord. Min. Flow	Available H.P. Ord. Six-Month Flow
Magpie	Michipicoten River	4,310	8,620
Shikwamkwa	" "	883	3,151
Michipicoten	Lake Superior	6,183	22,097
Sand	" "	190	655
Agawa	" "	507	1,808
Montreal	" "	5,767	20,681
Batchawana	" "	371	1,329
Chippawa	" "	233	832
Goulais	" "	2,196	4,647
St. Mary's	" Huron	(1) 53,600	(2) 65,800
Mississagi	" "	31,486	66,089
Little White	Mississagi River	451	945
Spanish	Lake Huron	36,820	59,499
Aux Sable	Spanish River	4,790	14,197
Vermillion	" "	3,840	17,276
Onaping	Vermillion River	1,619	7,293
Whitson	" "	....	....
Whitefish	Lake Huron	961	2,303
Wahnepetei	" "	9,221	13,835
Sturgeon	" Nipissing	12,487	23,275
Timagami	Sturgeon River	3,268	6,088
French	Lake Huron	15,750	29,350
South	" Nipissing	2,234	6,066
Guiness	South River	....	....
Trout Cr.	" "	....	....
Quinze	Lake Temiskaming	69,580	176,010
Ottawa	St. Lawrence River	51,170	84,860
Blanche	Lake Temiskaming	7,193	15,631
Victoria Cr.	Blanche River	....	....
Raven	" "	332	724
Wright Cr.	" "	5	12
Montreal	Ottawa River	19,982	43,387
Bear	Montreal River	81	177
Lady Evelyn	" "	1,420	3,088
Mattawa	Ottawa River	1,325	2,912
Amable du Fond	Mattawa River	3,353	7,302
Matabitchuan	Ottawa River	2,978	6,439
Missinaibi	Moose River	9,893	21,219
Opasatika	" "	2,755	6,875
Kapuskasing	Mattagami River	7,226	16,835
Trout	Kapuskasing River	304	714
Kebwashi	" "	....	....
Groundhog	Mattagami River	2,162	5,500
Mattagami	Moose River	129,490	242,170
Black	Abitibi River	493	1,052
Shallow	Black River	38	83
White Dog	" "	45	100
Driftwood	" "	....	....
Frederick House	Abitibi River	4,846	13,317
Abitibi	Moose River	216,653	335,946
	Totals	727,591	1,360,189

Notes (1) and (2).—Equal amounts are available in the U.S.

TABLE 2.—GROWTH OF DEVELOPED WATER-POWER IN THE "AREA"

1	2	3
Date	Installed during Year H.P.	Total at end of Year H.P.
1890 and before	65	65
1891	..	65
1892	..	65
1893	..	65
1894	..	65
1895	75	140
1896	286	426
1897	..	426
1898	..	426
1899	..	426
1900	6,300	6,726
1901	....	6,726
1902	7,290	14,016
1903	....	14,016
1904	10,870	24,886
1905	8,700	33,586
1906	600	34,186
1907	1,600	35,786
1908	4,100	39,886
1909	12,500	52,386
1910	15,425	67,811
1911	23,210	91,021
1912	15,000	106,021
1913	8,200	114,221
1914	26,880	141,101
1915	5,500	146,601
1916	9,300	155,901
1917	21,250	177,151
1918	21,770	198,921
1919	1,600	200,521
1920	250	200,771
1921	36,050	238,821
1922	....	238,821
1923	13,250	250,071
1924	46,750	296,821

These figures afford striking evidence of steady and continuous growth in the utilization of the water power resources of the "Area." A total installation of 65 horse-power at the end of 1890, increased to 6,726 horse-power by the end of 1900, to 67,811 horse-power by the end of 1910, to 200,771 horse-power by the end of 1920, and to 296,821 by the end of 1924. This last amount includes the 24,000 horse-power development of the "Hollinger" which is under construction but which should be completed before the end of the year. It also includes the 20,000 horse-power development just completed at Kekek Falls on the Quinze River. While this development is over the Quebec boundary, the main market for the power is the gold mining area in Ontario.

There is also at the present time one other development under construction,—at Wendigo Falls on the Blanche River. Associated

Gold Fields, Ltd., is installing turbines with a total capacity of 6,000 horse-power at this site.

Data concerning the individual power plants in the "Area" are listed below in Table No. 3.[6] Reference should also be made to Plate II for location.

Two hundred and ninety-six thousand eight hundred and twenty-one horse-power developed is a strikingly large total, especially when consideration is given to how sparsely settled is this portion of the country. It is indicative of the importance of power to the industries of the district.

Analysis with regard to type of development.

Under this heading the stations are classified as "Central Electric Stations" or as "Private Purpose Plants." By "Central Electric Stations" are intended stations developing power for sale or distribution to other users; by "Private Purpose Plants" are intended stations developing power for use by the company or organization owning or controlling the said stations.

In Table No. 3, of the 296,821 installed horse-power, 172,124 is classed under Central Electric Stations and the remaining 124,697 horse-power under Private Purpose Plants. In other words, 58% of the installed power of the "Area" is in plants classed as "Central Electric Stations," while the other 42% is for private use.

Analysis with regard to Distribution.

(1) *By Rivers.*—It is found by an examination of the table that, of the 296,821 horse-power installed in the district, 255,300, or 86% is installed on 7 or 29% of the rivers as follows: Abitibi, 76,000; St. Mary's, 42,450; Spanish, 41,920; Mattagami, 37,150; Quinze, 20,000; Montreal, 19,190, and Sturgeon, 18,590 horse-power. The remaining 41,521 horse-power is divided up among 17 rivers, in amounts varying from 30 horse-power on the Wright, to 11,000 horse-power on the Matabitchuan.

(2) *By Districts.*—On Plate II it will be noticed that power is transmitted from the various power plants to several different centres and it is with regard to these centres that the following analysis is made.

Porcupine.—There are at present four plants supplying this district with its power. These are Nos. 223, 234 and 235 on the Mattagami River and No. 173 on the Montreal River. These plants have a total installation of 32,100 horse-power. With the completion of the Hollinger (No. 257) and Quinze River (No. 138) developments with their attendant transmission systems, the Porcupine field will have an additional 44,000 horse-power available.

TABLE 3.—DEVELOPED WATER-POWER IN THE "AREA"

River	Site No.	Site Name	Location	Head in Feet	Installed H.P.	Type of Dev.	Owner
1	2	3	4	5	6	7	8
Magpie	6	Steep Hill Falls	Steep Hill Falls	68	2,600	P.P.	Algoma Steel Corp. Ltd.
Michipicoten	13	High Falls	6 miles above mouth	125	1,600	CES.	Algoma Power Co.
St. Mary's	29	Sault Ste. Marie	At Sault Ste. Marie	18	14,400	P.P.	Great Lakes Power Co.
					28,050	CES.	Lake Superior Paper Co.
Spanish	57	High Falls	3 miles above turbine	85	21,300	P.P. & CES.	Huronian Co. Ltd. P.P 64%, CES. 36%
"	58	Nairn Falls	Above Nairn Sta., C.P.R.	29	4,800	CES.	Lorne Power Co.
"	59	Espanola Falls	At Espanola	63	15,820	P.P.	Spanish River Pulp and Paper Mills Ltd.
Vermilion	81	Lorne Falls	4 miles from Nairn Centre	70	4,800	CES.	Lorne Power Co.
"	82	McPherson Falls	16 miles west of Sudbury	27	1,300	P.P.	Sudbury Flour Mills Ltd.
Whitson	88		At Chelmsford		65	P.P.	Adelard Chenies
Wahnapetei	107		1.5 miles below Wahnapetei Sta.	53	6,300	CES.	Wahnapetei Power Co.
"	108		At McVitties Stn., C.N.R.	38	3,600	CES.	Wahnapetei Power Co.
Sturgeon	120	Sturgeon Falls	In town of Sturgeon Falls	36	13,390	P.P.	Spanish River Pulp and Paper Mills Ltd.
"	121	Smoky Falls	14 miles above L. Nipissing	35	5,200	P.P. & CES.	Spanish River Pulp and Paper Mills Ltd. P. P., 75%, C.E.S. 25%
South	133	Bingham Falls	Lot 22, Con. 13, Hamsworth Tp.	45	1,200	CES.	Ont. H.-E. Power Com.
"	134		Near South River Stn.	64	460	P.P.	Ward & Richards
"	135		2⅛ miles above Nipissing	90	2,200	CES.	Ont. H.-E. Power Com.
Guiness	136		At Powassan	28	40	P.P.	Alf. Mitchell
Trout Creek	137		At Trout Creek	28	75	P.P.	Toussler Bros.
Quinze	138	Kekek	Below Quinze Lake	90	20,000	CES.	Northern Canada Pr. Co.
Blanche	162	Charlton Falls	At Charlton	37	1,080	CES.	Nor. Ont. Light and Power Co.

River	Site No.	Site Name	Location	Head in Feet	Installed H.P.	Type of Dev.	Owner
1	2	3	4	5	6	7	8
Raven	164	Raven R. Falls	Between Lardu and Raven Lakes	96	1,600	P.P.	Assoc. Gold Fields Co.
Wright	165		Nedelec Que.	12	30	P.P.	D. Cloutier
Montreal	173	Indian Chutes	North of Elk Lake, Ont.	47	4,300	CES.	Gt. Nor. Power Co.
"	174	Hound Chutes	6 miles south of Cobalt	325	5,340	CES.	Nor. Ont. Light & Power Co.
"	175	Ragged Chutes	4 miles east of Johnston Stn.	48	5,500	CES.	Nor. Ont. Light & Power Co.
"	176	Fountain Falls	9.5 miles south of Cobalt	30	3,000	CES.	Nor. Ont. Light & Power Co.
"	177	Hangingstone Falls	5 miles from Gowganda	67	250	CES.	South Bay Power Co.
"	178	Gowganda Falls	At outlet of Gowganda Lake	29	800	C.ES	Gowganda Power Co.
Bear	179	Elk Lake	In town of Elk Lake	14	350	CES.	Elk Lake Power Co.
Mattawa	187		2 miles from Mattawa	12	286	CES.	Mattawa El. L. & Power Co.
Matabitchuan	195		At Matabitchuan Portage	312	11,000	CES.	Nor. Ont. L. & P. Co.
Kapuskasing	217	Spruce Falls	Kapuskasing	30	2,500	CES.	Spruce Falls Co.
Kabakwaska	219		2 miles from Chapleau	50	400	CES.	J. McNaustin
Mattagami	223	Sturgeon Falls	Mahaffy Tp., Temiskaming D.	42	8,000	CES.	Nor. Can. Power Co.
"	234	Wewaitin Falls	At foot of Kenogamissi Lake	125	14,900	CES.	Nor. Can. Power Co.
"	235	Sandy Falls	6 miles N.W. of Timmins	32	4,900	CES.	Nor. Can. Power Co.
"	236	Smooth Rock Falls	Town of Smooth Rock Falls	36	9,350	P.P.	Mattagami Pulp & Paper Co.
Driftwood	242		At Monteith	10	35	P.P.	Ont. Govt. Exp. Farm
Abitibi	255	Twin Falls		60	24,000	P.P.	Abitibi Power & Paper Co.
	256	Iroquois Falls		425	28,000	CES.	Abitibi Power & Paper Co.
	257	Island Falls	40 miles north of Cochrane	60	24,000	P.P.	Hollinger Cons. Gold Mines
					296,821		

Column 2 gives the same number to the plant as given to it in Table No. A.
Column 7—C.E.S. stands for Central Electric Station and P.P. stands for Private Purpose Plant.

Under Construction

Blanche	Wendigo Falls	Wendigo	6,000	CES P.P.	Associated Gold Fields Ltd.

Kirkland-Larder-Cobalt District.—Five plants supply the power needs of this area. Three of these, Nos. 174, 175 and 176, are on the Montreal River and transmit power to the silver mining operations at Cobalt as well as to the Kirkland Lake Gold area. The fourth plant (No. 162) is on the Blanche River and also serves the Kirkland Lake gold mining industry. The fifth plant (No. 164) is on Raven River and supplies power to the Larder Lake gold field. The total installation of the above five plants is 16,520 horse-power.

Sudbury District.—The nickel mining industry around Sudbury is supplied with power from two plants on the Spanish River (Nos. 57 and 58); one on the Vermilion (No. 81), and two on the Wahnapitae River (Nos. 107 and 108). The total installation in these five plants is 40,800 horse-power and a very high percentage of their output is used in the mining and smelting operations of the copper and nickel industry.

Sault Ste. Marie.—At this point there is installed by two companies on the Canadian side of the St. Mary's River a total of 42,450 horse-power. These two developments are listed in Tables A and 3 and on Plate II as site No. 29.

Reference to Plate II shows the scattered layout of the power plants serving the pulp and paper industry in the "Area." The location of these plants for the most part coincides with the location of the mills and pulpwood limits of the companies.

Analysis with Respect to Ownership.

It will be seen from Column 8 of Table 3 that many companies operate more than one power plant. Thus the Northern Ontario Light & Power Co. operates plants 174, 175 and 176 on the Montreal River, and 162 and 195 on the Blanche and Matabitchuan Rivers respectively. The total installation of this Company's five plants is 25,920 horse-power. The Northern Canada Power Co. has four power plants. Three of these, Nos. 223, 234 and 235, are on the Mattagami River; the fourth, No. 138, is on the Quinze River. The total installation of these four is 47,800 horse-power. The Spanish River Pulp & Paper Mills, Ltd., operates plants 59, 120 and 121, with a total installation of 34,410 horse-power. Similarly the Abitibi Power & Paper Co. operates two power plants with a total installation of 52,000 horse-power. In addition to the above, the Wahnapitae Power Co., the Lorne Power Co. and the Hydro-Electric Power Commission each operate two stations.

(2) *Transmission and Distribution of Power.*

In this section it is proposed to deal with the existing transmission and distribution systems in the "Area." By the transmission of power is meant the conveying of power at high voltage from the

power plant to the locality in which it is to be used, while by the distribution of power is intended the retailing of the power to the different users at a much lower voltage.

The large majority of transmission lines in the "Area" (see Plate II) are for the purpose of supplying power to the mining industry. Thus the Northern Canada Power Co. has approximately 65 miles of transmission lines supplying the Porcupine area from its three plants on the Mattagami River and has recently completed a 125-mile[7] line from its Quinze River station to the same field. The Great Northern Power Co. also transmits power to Porcupine from its Montreal River development, a distance of some 60 miles. In the Larder Lake and Cobalt districts the Northern Ontario Light and Power Co. has some 163 miles of transmission lines from which power is distributed to the gold and silver mines and for street and residential lighting. The International Nickel Co. operates 40 miles of wooden pole transmission lines from plant No. 57 to Copper Cliff, Creighton Mine and O'Donnell at 34,000 volts. The distribution system consists of 15 miles of pole lines, primaries 2,200 volts and secondaries 110 volts.[8] The Wahnapitae Power Co., Ltd., owns 16 miles of wooden pole transmission lines connecting its plants Nos. 107 and 108, and 10 miles of wooden pole lines leading into Sudbury. In Sudbury the Company's distribution system consists of 4 miles of wooden pole lines; primaries 2,200 volts, secondaries 110 and 550 volts.[9] The Lorne Power Co., Ltd., transmits power over 78 miles of wooden pole lines from its two plants No. 58 and No. 81 to substations at Worthington, Mond, Garson, Levack and Coniston at 44,000 volts.[10] Other companies and their transmission systems are: Associated Gold Fields, 15 miles; Algoma Power Co., 6 miles; Algoma Steel Corporation, 20 miles, and the Spanish River Pulp and Paper Mills, Limited, 10 miles. Furthermore, the Hollinger Consolidated Gold Mines intends transmitting power from its new development on the Abitibi River to Porcupine, a distance of some 80 miles.

(3) *Future Trend in Power Development.*

Modern tendency in the practice of hydro power development and transmission is towards amalgamations into what have been termed super power systems. A very good example of this is that of the Ontario Hydro-Electric Power Commission, which has absorbed practically all competition in its territory. The principal advantages to be secured from such amalgamations are:

(1) A more reliable supply of power due to the fact that if one plant goes out of commission the other plants in the system are available to make up, at least to some extent, the deficiency.

(2) A more reliable power service owing to the interconnection of transmission lines.

(3) A more stable power market due to broader and more diverse uses of power.

(4) Elimination of unnecessary duplication of transmission lines and other equipment with their contingent capital investment for which annual charges must be provided.

Within the "Area" considered herein, in the early days, water powers were developed to supply particular mining and pulp and paper districts. As the development of the country proceeded, these plants, along with new developments, transmitted power into new territories. This resulted in duplication of transmission and distribution systems and the advisability of merging the different systems soon became evident.

Recent press reports indicate that such a merger is being considered among the northern power interests at the present time. Quite recently it has been reported that the Northern Canada Power Company will absorb the Great Northern Power Company, and ultimately is likely to bring the Northern Ontario Light & Power Company, which is virtually under the same control, into the merger.

VII. Relationship of Available Power to Developed Power in the Area.

It is desirable to establish the relationship existing between turbine installation and available resources in the "Area."

First, it might prove of interest to develop the relationship for the Dominion as a whole and later to compare this figure with that for the "Area."

The available power expressed as stream capacity cannot be directly compared with the developed water-power as represented by turbine horse-power installed, since the installed horse-power always considerably exceeds the calculated stream capacity. The installed horse-power required to utilize a given stream capacity depends upon the load factor, as well as the pondage facilities. It must also provide for spare units.

An analysis of Canadian water-power plants scattered from coast to coast, concerning which complete data are available as to turbine installation and satisfactory information as to stream flow, gives an average machine installation 30% greater than the six-month flow maximum power. Applying this to the 32,076,000 h.p., which is the total for the Dominion, dependable for at least six months of the year, indicates that Canada's *present recorded water-power resources* will permit of a turbine installation of 41,700,000 h.p.[11]

The total installation to date in waterwheels and turbines throughout the Dominion is 3,227,414 h.p.[12] In other words, the present turbine installations represent only 8% of the recorded water-power resources.

A similar analysis of the plants throughout the "Area" which are completely installed, shows a turbine installation 37% greater than the power indicated as being available for six months of the year. This six months available power, 1,360,189 h.p. as totalled in Table 1, if developed on the basis at present obtaining in the "Area," would permit of a turbine installation of 1,863,460 h.p.

The present installation within the "Area" is 296,821 h.p. or only 16% of the possible installation as established in the foregoing paragraph. It is apparent, therefore, that the power resources of the district are sufficient to permit of greater expansion of the Northern Ontario industries.

VIII. The Relationship of Water-Power Resources of the "Area" to the Mining Industry.

Canada is fortunate in the possession of areas where mineral wealth and water-power lie in close proximity. This is in no place better exemplified than in the "Area" considered herein, where there are large gold, silver and nickel mines in close proximity to nearly one and a half million horse-power available for six months of the year.

It will be seen from the following pages that the mineral industry of the "Area" has three outstanding characteristics, viz., rapid growth, proximity of water-power and the domination of the world's markets as regards certain metals, nickel and cobalt.[13] As a producer of gold, Ontario now stands third among the countries of the world, being exceeded only by the Union of South Africa and the United States of America. During the last twenty years Ontario has also taken a leading place as a producer of the sister metal, silver. The more important of the Province's gold and silver mines are located in this "Area."

In no other part of the world to-day is there more intense interest in the search for and the development of mining properties. The success achieved in recent years, and the large areas awaiting the prospector and the miner, lead to the belief that the industry in this section of the province offers great promise for the future.

The Mineral Resources of the "Area."

Gold.—The discovery of the world-famous silver deposits of Cobalt in 1903 during the construction of the Temiskaming and Northern Ontario Railway resulted in intense and widespread prospecting in this district. Prospectors spread out from the railway line as it was extended northwesterly from Cobalt towards Cochrane, and made successive discoveries of gold-bearing ore, of which the greatest were those of the Porcupine in 1909, followed by Kirkland Lake in 1912. The finding of these gold-bearing areas has changed the status of gold mining in Ontario from one of insignificant proportions to that of an industry which is attracting the attention of the mining world.[14]

The Porcupine gold camp includes such well known mines as the Hollinger Consolidated, Dome, McIntyre, Vipond Consolidated and Clifton Porcupine. The Kirkland Lake camp includes the Wright-Hargreaves, Kirkland Lake, Teck-Hughes, Lake Shore and Kirkland Lake Proprietary mines. Other active areas in the district are Larder Lake, Night Hawk Lake, Matachewan, Abitibi Lake, Goudreau and Shining Tree.

In Table No. 4,[15] hereunder, the value of the total gold output of the province, exclusive of premium, is given; also that from Porcupine and Kirkland Lake, beginning in 1910 and 1913 respectively.

TABLE NO. 4—PROGRESSIVE GOLD OUTPUT FROM PORCUPINE AND KIRKLAND LAKE

Year	Total Production in Dollars	Porcupine		Kirkland Lake	
		Dollars	Per Cent.	Dollars	Per Cent.
1892					
1909	2,509,492				
1910	68,498	35,539	51.8		
1911	42,637	15,437	36.2		
1912	2,114,086	1,730,628	81.8		
1913	4,558,518	4,294,113	94.1	65,260	1.2
1914	5,529,767	5,190,794	93.8	114,154	2.0
1915	8,501,391	7,536,275	88.6	551,069	6.5
1916	10,339,259	9,397,536	90.8	702,761	6.8
1917	8,698,735	8,229,744	94.5	404,346	4.6
1918	8,502,480	7,767,907	91.4	632,007	7.4
1919	10,451,709	9,941,804	95.1	486,809	4.7
1920	11,686,043	10,597,573	90.7	1,033,478	8.8
1921	14,624,085	13,095,630	89.5	1,524,851	10.4
1922	20,674,109	18,505,134	89.5	2,159,231	10.4
1923	20,082,586	17,313,115	86.2	2,647,630	13.2
Totals	128,383,395	113,651,229	88.5	10,321,596	8.0

As will be seen from the table, there has been a gratifying continuous yearly growth in the output of gold since 1910, when the Porcupine mills began producing bullion, except in 1911, owing to forest fires, in 1917 and 1918 when the decrease was due to adverse conditions caused by the war, and in 1923 when the output dropped below that of 1922 owing to a power shortage.

The value of gold produced in Ontario during 1923 was $20,082,586.[16] Of this Porcupine supplied $17,313,115 or 86.2%, and Kirkland Lake $2,647,630 or 13.2%. In other words, these two camps alone supplied 99.4% of the gold produced in Ontario during 1923. These same two camps which lie within the "Area" had provided 96.5% of Ontario's total production to the end of 1923, valued at $128,383,395.

One of Porcupine's mines, the Hollinger, ranks with the greatest mines on the Rand in South Africa, both in amount of gold

produced and in the tonnage treated, while other mines in the "Area" are among the largest of gold producers. The Hollinger to the end of 1923 had produced $71,350,112[17] of gold bullion. Owing to the youthfulness of the operating mines, the increased tonnages being treated, the enlargement of the ore reserves, the opening up of new properties and the extensive areas awaiting development, the gold production of Ontario should increase for years to come.

Silver.—The first discovery of silver in the "Area" is frequently credited to a French-Canadian blacksmith named Fred La Rose, whose business was to sharpen the drills of a railway construction gang, and who is alleged to have thrown a piece of steel at a prowling fox, and on seeking his missile found that it had knocked off a fragrant of reddish copper-like mineral which proved to be niccolite, subsequently found to be associated with native silver. This was at Long Lake during the construction of the Temiskaming and Northern Ontario Railway. The name Long Lake was subsequently changed to Cobalt Lake and the surrounding area became known to fame as the Cobalt Silver Camp.

It is understood, however, that the first discovery of silver was made by James H. McKinley and Ernest Darragh, woodsmen, on 7th August, 1903, but proof of this discovery was not filed with the authorities until the 6th October, whereas La Rose's application was made 29th September.[18]

Old mining men were very skeptical as to the discoveries, regarding them as freaks and actual development was held up for a time. However, from 1904 to 1911 the output of silver increased very rapidly year by year. In 1911 the peak of production was reached, when 31,507,791 fine ounces of silver were obtained, the value of which was $15,953,847.[19] In 1912 the output dropped a little but the value increased to $17,408,935,[19] due to a rise in price. Since 1911 the production has been declining, but the life of the camp has been prolonged by the finding of blind veins and especially by improvements in metallurgy which have enabled low grade ore to be profitably mined. Recently the silver production is again rising due to the finding of large bodies of valuable ore in South Lorrain. This camp was practically abandoned but rich veins were struck in the Keeley and Frontier mines, with the result that during 1923 Keeley shipped 1,655,323 ounces and Frontier 1,300,323 ounces of silver.[20] It is believed that there are good prospects of finding additional ore deposits in this district and different companies are at work near Trout Lake. Work is also proceeding in the Gowganda district containing the Miller, Lake O'Brien and Castle Trethewey mines.

By camps the production to 31st December, 1923, has been as follows:[21]

Area	Ounces
Cobalt	327,301,897
South Lorrain	7,295,580
Gowganda	6,467,296
Casey Township	2,799,740
Montreal River and Maple Mountain, etc.	31,267
Total	343,895,780

An average of 2.1 tons of pure silver has been obtained from the Cobalt mines for every 24 hours since they began to yield. The total production of silver in the "Area" to the end of 1923 aggregates 343,895,780 ounces.

Nickel.—The first deposit of nickel copper was discovered during the building of the Canadian Pacific Railway in 1883. In the following two or three years other discoveries were made and in 1886 serious mining operations commenced on a deposit rich in copper, the presence of nickel in the ore not being detected until 1887.

Table No. 5[22] records mining and smelting operations for the last pre-war year, the year of maximum output, and also for the past three years, showing that production has returned to better than a pre-war basis:

Table No. 5—Nickel Copper Statistics

Schedule	1913	1918	1921	1922	1923
Ore raised—tons	784,697	1,643,040	262,593	259,569	1,187,354
Ore smelted—tons	823,403	1,559,892	393,768	314,120	1,140,160
Bessemen matte produced—tons	47,150	87,184	19,498	17,324	58,084
Nickel content of matte—tons	24,838	45,886	9,128	8,678	31,029
Copper content of matte—tons	12,938	23,843	6,323	5,422	15,769
Matte exported—tons	.....	.....	10,466	19,831	21,450
*Matte refined in Canada—tons	.....	5,334	5,558	10,340	31,765

*Refining in Canada began at Port Colborne in 1918.

The total production of nickel from the mines in the Sudbury district from 1889 to the end of 1923 was approximately 474,096 short tons.[23] In the Sudbury ores nickel and copper are always associated and statistics show that nickel occurs in about twice the quantity that copper does.

About 90% of the world's nickel comes from the vicinity of Sudbury, and there are no known deposits elsewhere which can compare with those of this area, either as regards size or in the cheapness of producing the metal. The Sudbury deposits are so

large that they may be considered sufficient for the wants of this and the succeeding generation.

Outside of the Sudbury area, the only producers of nickel in Ontario are the silver mines of Cobalt. But much of the nickel in these complex ores is lost in refining the silver and other constituents.

During the war the demand for nickel increased enormously. It was used in the form of nickel steel in the manufacture of armour plate, guns, etc. While little of it is now used for war material, the demand for nickel in the arts of peace has become so great that the production of nickel ores in the Sudbury area is now larger than it was in the period immediately preceding the war.

Other Minerals.—In addition to the above-mentioned minerals there are several others found in the "Area" which are worthy of mention.

Iron was mined for some years in the Michipicoten area and large bodies of iron ore are known to exist there and in the Moose Mountain district north of Sudbury. Many signs indicate an early revival of the iron mining industry in Ontario.

Copper has been mined in the "Area" since 1886, and to the end of 1922 approximately 259,890 tons of metal had been produced. This copper was mined in the Sudbury district in association with the nickel ores.

The silver ore in South Lorrain is particularly high in cobalt. This latter mineral in the form of an oxide dominates the world's markets supplying the manufacturers of ceramic ware and other users in Britain, Europe and Japan.

Arsenic is found in the Cobalt ores to as high as 30%, and is much in demand for the making of insecticides.

Platinum, palladium, rhodium, iridium, as well as gold and silver and other metals of the platinum group, are present in the nickel-copper ores in the Sudbury area. These metals are recovered as by-products where either the Mond or the electrolytic process of refining the nickel is employed.

It will be seen from the last few pages that the mineral wealth of the "Area" is enormous.

Relation of Power to the Mining Industry.

The district is situated in what has been termed the "acute fuel area" of the Dominion and embraces no native coal resources. It is, therefore, dependent almost entirely on the abundant supplies of hydraulic and hydro-electric energy which are, fortunately, available.

The major hydraulic developments for mining are located in the gold, silver and nickel areas of Northern Ontario in which plants, to the beginning of 1924, over 107,000 h.p.[24] were installed, with several large additional installations nearing completion.

This power has many uses in the mines. The principal ones are compressing air for drilling; driving motors or engines for hoisting; haulage of ore above and below ground; driving ore crushers and conveyors; pumping for water and for removal of ground water; lighting; heating; ventilating; signalling; operating machine, blacksmith and framing shops and for various electro-metallurgical processes. Briefly, large amounts of power are necessary in every branch of the mining industry from the preliminary drilling to the final refinement of the product. When there is added to this the statement that in the comparatively simple process used in coal mining as much as 10% of the product may be used in developing the necessary operating power, the importance of low-priced power becomes strikingly apparent. This is stressed by the fact that coal mines, where possible, are abandoning fuel power in favour of hydro-electricity.

Utilization of Water-Power in the Gold Mining Industry.

Both the Porcupine and Kirkland Lake camps use large amounts of hydro-electric power in operating their gold mines. There are at present four developments, with a total installation of 32,100 horse-power, transmitting electrical energy to the Porcupine field. Three of these, owned by the Northern Canada Power Company, namely, Nos. 223, 234 and 235 on Plate II and in Tables A and No. 3, are on the Mattagami River. The fourth is on the Montreal River above Elk Lake and is owned by the Great Northern Power Co. This development was rushed to completion in 1923 to cope with the power shortage existing at Porcupine, and is shown on the map as No. 173. In the official record of the Hollinger Consolidated Gold Mines it is shown that up to July 13, 1923, there was a loss in production attributable to power shortage of 522,778 tons, averaging $8.15 per ton, representing a grand total value of $4,261,-559.46.[25] So serious had this shortage become that the Hollinger Company announced its intention of developing 24,000 horse-power on the Abitibi River to supply its wants. Shortly afterwards the Northern Canada Power Company announced plans to build a plant on the Quinze River in Quebec, with an ultimate capacity of 60,000 horse-power. With an initial installation of 20,000 h.p. completed on the Quinze River and with the Abitibi development rapidly nearing completion, Porcupine power troubles would seem to be nearly at an end.

Kirkland Lake is served entirely by the Northern Ontario Light and Power Co. This power company has 1,080 h.p. installed in plant No. 162 on the Blanche River and also transmits power from its plants in the Cobalt silver mines.

Larder Lake is supplied by the 1,600 h.p. development No. 164 on the Raven River belonging to the Associated Gold Fields.

Utilization of Water-Power in the Silver Mining Industry.

The demands of the Cobalt silver area are met by plants Nos. 174, 175, 176 and 195 shown on Plate II. These plants are all owned by the Northern Ontario Light and Power Co. The first three are on the Montreal River, while No. 195 is on the Matabitchuan River. No. 175 is a hydro compressed air plant and is equivalent to 5,500 horse-power. The total installation of these four plants is 24,840 horse-power, most of which is used in the Cobalt silver mining industry.

Two small developments, Nos. 117 and 178, on the Montreal River, supply the Gowganda silver mines with power. The former is owned by the South Bay Power Co. and has an installation of 250 h.p.; the latter, with an installation of 800 h.p., is the plant of the Gowganda Power Co.

These plants, with a total installation of approximately 26,000 h.p., are supplying the power wants of the silver mines.

Large blocks of power are necessary in refining the silver ore as is indicated by the fact that silver refineries are located at Thorold and Welland in the area of cheap hydro power.

Utilization of Water-Power in the Nickel Mining Industry.

Water-power is used to a large extent in the nickel mining industry, as in the gold and silver mining industries. Plants Nos. 107 and 108 on Plate II are located on the Wahnapitae River and are owned by the Wahnapitae Power Co., Ltd. The total installation of these two plants is 9,900 h.p. and the output is sold to the town of Sudbury, the bulk of which is resold for nickel and copper mining. Plant No. 57 is a double development at High Falls on the Spanish River owned by the Huronian Co., a subsidiary of the International Nickel Co. Ninety-four per cent. of the output from a total installation of 20,600 h.p. is used by the International Nickel Co. for lighting, mining and smelting. Plant No. 58, owned by the Lorne Power Co., which is a subsidiary to the Mond Nickel Co., Coniston, is located at Nairn Falls on the Spanish River. 4,800 h.p. is installed here, while a further 4,800 h.p. is installed at this Company's plant on the Vermilion River (Plant No. 81). The total output of these two plants is purchased by the Mond Nickel Co. for copper nickel mining and treatment.

Nickel refineries using hydro-electric power are also located at Port Colborne, Ontario, and Des Chenes, Quebec.

It will be seen from the above that there are hydraulic turbine installations aggregating approximately 103,000 horse-power, supplying the power needs of the mining industry in the "Area" as outlined. To this figure should be added the 20,000 h.p. installation just completed on the Quinze River for the Northern Canada Power

Co. and the 25,000 h.p. development of the Hollinger Consolidated Gold Mines, nearing completion on the Abitibi River. These two sites are numbered 138 and 257 respectively on Plate II and Tables A and No. 3. The addition of these two plants raises the total to approximately 150,000 h.p. serving the mining industry of the "Area."

Conclusions.

Hydro-electric power in Northern Ontario has done much for the mining industry. In many cases large scale operations, which alone make the difference between profit and loss, are only made possible by abundant supplies of low-priced hydraulic power. Many mines, on account of their geographical location, would find the cost of rail haul of fuel or untreated ore prohibitive, but with hydraulic power profitable operation has been possible and much low grade material has been given commercial value.

IX. Relationship of Water-Power Resources of the "Area" to the Pulp and Paper Industry

The following basic facts[26] give some idea of the importance of the pulp and paper industry to Canada. 1. At January 1, 1923, the capital invested in the pulp and paper industry in the Dominion amounted to over $380,000,000, a figure only exceeded by our investment in steam railways and central electric stations. 2. The exports of the products of the industry during 1922 were valued at approximately $123,000,000, and were of greater value than those of any other group except that of vegetable products. 3. The industry maintained a staff of 25,830 persons (exclusive altogether of the men employed in the woods) whose salaries and wages for the year 1922 amounted to $32,918,955. 4. The net value of the products for 1922 totalled $155,785,388.

The Pulp and Paper Resources of the "Area."

The pulp and paper resources of the "Area" are found in its immense forests. Several species of trees suitable to the industry are found in this district. Spruce is the main pulping species. Its superiority lies in its strong, tough, colourless fibre. Balsam, poplar and jack pine, as well as hemlock are found in the district. Jack pine has been used for pulping only to a small degree, although large quantities are available.

The pulp industry in Ontario uses spruce to the extent of over 90%, and balsam about 5%.[27] The balance is made up of small quantities of poplar, hemlock and jack pine.

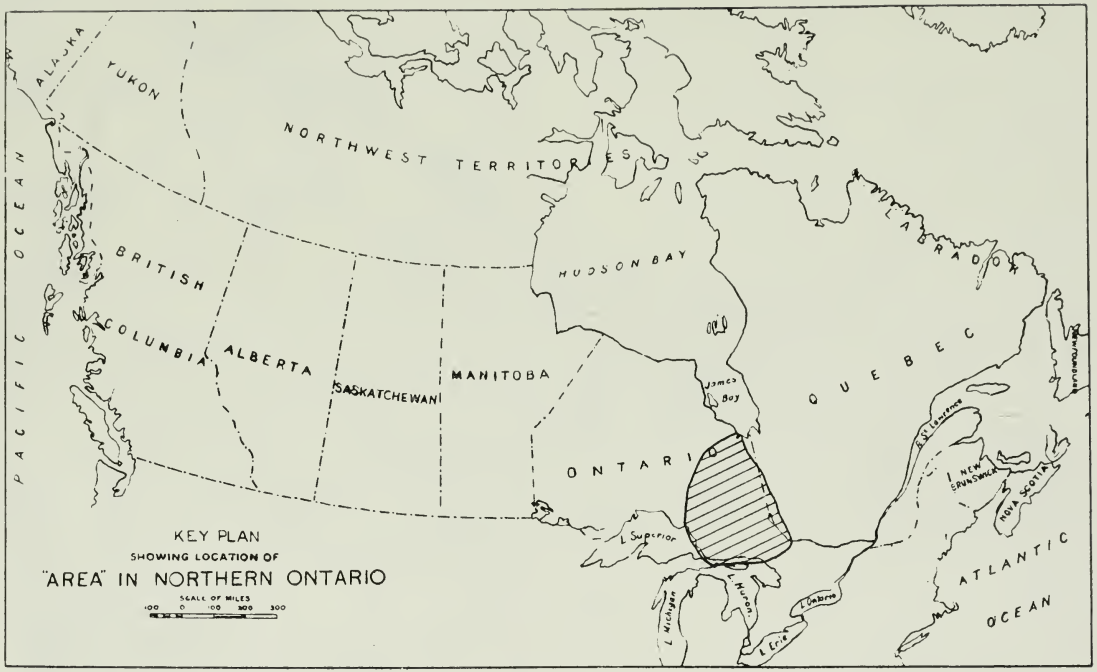

ALASKA
YUKON
NORTHWEST TERRITORIES
PACIFIC OCEAN
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
HUDSON BAY
LABRADOR
QUEBEC
James Bay
ONTARIO
St Lawrence
NEW BRUNSWICK
NOVA SCOTIA
L Superior
L Michigan
L Huron
L Erie
L Ontario
ATLANTIC OCEAN
KEY PLAN
SHOWING LOCATION OF
"AREA" IN NORTHERN ONTARIO
SCALE OF MILES
100 0 100 200 300

PLATE I

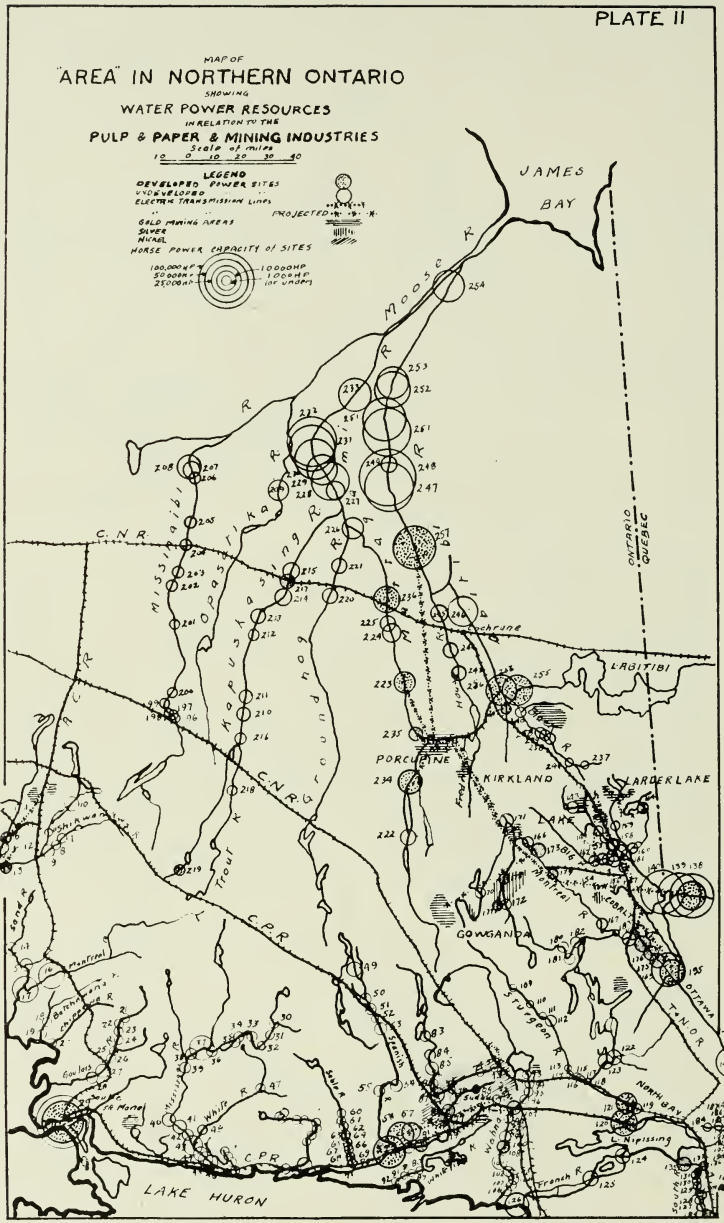


PLATE II
MAP OF
"AREA" IN NORTHERN ONTARIO
SHOWING
WATER POWER RESOURCES
IN RELATION TO THE
PULP & PAPER & MINING INDUSTRIES
Scale of miles
10 0 10 20 30 40
LEGEND
DEVELOPED POWER SITES
UNDEVELOPED
ELECTRIC TRANSMISSION LINES
PROJECTED
GOLD MINING AREAS
SILVER
NICKEL
HORSE POWER CAPACITY OF SITES
100,000 HP
50,000 HP
25,000 HP
10,000 HP
1,000 HP
(OR UNDER)
JAMES BAY
MOOSE R.
ONTARIO
QUEBEC
C.N.R.
LABITIBI
PORCUPINE
KIRKLAND
LAKE
LARDER LAKE
GOWGANDA
OTTAWA R.
TEMIS R.
NORTH BAY
Nipissing
LAKE HURON
C.P.R.
Mattagami R.
Sturgeon R.
Trout R.
Mississagi R.
Opasatika R.
Mapuskasing R.
Groundhog R.
Frenchman R.
Sucker R.
Spanish R.
Vermilion R.
Bonnechere R.
Gouldais
Sault Ste Marie
Mississagi R.
Whitefish R.
Sucker R.
Wanapitei R.
Trench R.
Sudbury
Sault Ste Marie

Relation of Power to the Pulp and Paper Industry.

In the production of pulp and paper an adequate supply of power is almost equal in importance to that of raw materials.

In Canada the bulk of the paper produced is newsprint, which consists of approximately 80% mechanical pulp or groundwood, which gives to the sheet its characteristic, to quickly absorb the ink when run through a modern high speed printing press, and 20% chemical or sulphite pulp, which is necessary for the requisite strength.

The production of mechanical pulp requires about 75 h.p. per ton per day, while that of chemical pulp requires about 22 h.p. The actual conversion or paper-making process adds from 15 to 25 h.p., so that for the manufacture of one ton per day of newsprint from 90 to 100 horse-power are required.[28] One large and representative Canadian mill uses on the average 73 h.p. for each ton of mechanical pulp produced, 67 h.p. of which is for the actual grinding alone. The production of sulphite pulp for mixing with groundwood pulp requires 8.7 h.p. per ton of daily output (in certain large mills as high as 30 h.p. is used per ton of sulphite pulp produced), while the conversion of the pulp to newsprint requires 12 h.p. for the same unit of output.[29]

Utilization of Water-Power in the Pulp and Paper Industry.

In any industry the relative necessity of obtaining cheap and adequate power may be gauged by the amount required per dollar value of produce and, with the possible exception of certain electrochemical and metallurgical processes, the requirements for the manufacture of pulp and paper rank among the highest.

It is, therefore, not surprising that over 90% of the motive power in this industry in Canada is derived from the energy of the abundant and advantageously located water falls.

The main item in the cost per unit of power is in the interest on the capital expended in the hydraulic development. Since this is the same whether the plant operates 10 hours or 24, the continuous operation of mills in this industry, usually 24 hours per day, lends itself to the securing of a very low cost per unit of power. This unit cost has been further reduced in the development of the electric steam generator by which any surplus or off-peak power which may be available can be utilized for producing steam for pulp cooking, drying, heating, etc.

In dealing with the water-power utilized by this industry in the "Area" the different centres of pulp and paper production are dealt with separately.

Kapuskasing.—The Spruce Falls Co., Ltd., operate a pulp mill in the town of Kapuskasing. For the purpose of supplying its mill

with power, the Company also owns and operates a power plant at Spruce Falls, some 3 miles distant. The total installation at this plant is 2,500 h.p., part of which is sold to the town for lighting. The Company owns timber limits on this and the Opasatika Rivers. The daily production of the mill is rated at 120 tons of sulphite pulp.

Mattagami.—The Mattagami Pulp and Paper Co., Ltd., has operated a pulp mill at Smooth Rock Falls on the Mattagami River since 1916. The daily output of the mill is 150 tons of sulphite pulp. The Company supplies its own power by means of a turbine installation of 9,350 h.p., 9,000 h.p. of which is direct connected to generators.

The holdings[30] of the Company consist of: 1. Water rights.—The Company holds under lease from the Province of Ontario for 20 years with two 16-year renewals, two water-powers, one at Smooth Rock Falls on Mattagami River developed, and one at Yellow Falls on the same river, undeveloped. 2. Pulpwood limits.—The Company owns in fee simple 125 square miles of timber limits, and controls by lease from the Government of Ontario 840 square miles of Crown timber lands for 20 years with two 16-year renewal periods, estimated to contain 4,000,000 cords of spruce wood.

Abitibi.—The Abitibi area is being exploited by the Abitibi Power and Paper Co. This company operates large pulp and paper mills at Iroquois Falls, Ontario, and has a daily output as follows: Groundwood, 510 tons; sulphite pulp, 140 tons; newsprint, 500 tons; wrapping paper, 30 tons. To operate its mills it owns two water-power plants on the Abitibi River. One of these with a total capacity of 28,000 h.p., is located at Iroquois Falls, while the other, with an installation of 24,000 h.p., is at Twin Falls, 4¼ miles distant. Ninety-five point five per cent. of the power generated by this total turbine installation of 52,000 h.p. is used for pulp and paper manufacturing. The remaining 4.5 per cent. is sold for lighting.

The holdings[31] of the company consist of: 1. Water rights.—The company controls under lease dated September 17, 1912, for a period of twenty years, subject to two renewal periods of 16 years each, from the Government of Ontario, the two water-powers mentioned above. 2. Pulpwood limits.—The company controls under lease from the Government of Ontario, 1,560 square miles of pulpwood lands, estimated to contain over 5,000,000 cords of pulpwood. These lands are situated around Upper and Lower Abitibi Lakes and along the Abitibi River and its tributaries.

The company was incorporated under the laws of the Dominion of Canada on February 9th, 1914.

Spanish River.—There are two pulp and paper mills operating in this district: one at Sturgeon Falls on the Sturgeon River, the other at Espanola on the Spanish River. Both of these mills are owned by the Spanish River Pulp and Paper Mills, Limited, with head office at Sault Ste. Marie, Ontario.

Hydro power plants Nos. 120 and 121 on Plate II, the former with a total turbine installation of 13,390 h.p., and the latter with 5,200 h.p. installed, supply the power needs of the mill at Sturgeon Falls. The Espanola mill is supplied from plant No. 59 at Espanola, where there is a turbine installation of 15,820 h.p.

The holdings[32] of the company consist of: 1. Water rights.—The company develops its own water-power at Espanola and Sturgeon Falls. 2. Pulpwood limits.—Concessions from the Ontario Government are for 21 years from 1910 and comprise about 14,700 square miles, and have exclusive cutting rights from the Algoma Central and Hudson Bay Railway on 2,500 square miles. These limits are estimated to contain 12,000,000 cords of pulpwood.

This company, which was incorporated in 1900, also operates a pulp and paper mill at Sault Ste. Marie, Ontario.

Sault Ste. Marie, Ontario.—The only pulp and paper mill operating in this section of the "Area" is that of the Spanish River Pulp and Paper Mills, Limited, at Sault Ste. Marie, Ontario. This mill is supplied with pulpwood from the company's extensive forest area along the north-east shore of Lake Superior. The company has a turbine installation of 14,400 h.p. and buys its water from the Great Lakes Power Co. The pulpwood limits of the company are given in Section IX, page 42, under "*Spanish River.*"

In January, 1924, the total output of this company's three mills was given as: Newsprint, 700 tons daily; groundwood pulp, 650 tons; sulphite pulp, 290 tons; woodpulp board, 35 tons.[33]

From the foregoing sections it will be seen that there is an intimate connection between forests and water-powers, and the pulp and paper industry of Canada is deeply interested in both. The forests may be likened to the back-bone and frame of the industry, while the water-power constitutes the muscles and man-power the brains. The wood is required by the mill for raw material, the river is required in most cases to furnish cheap transportation of the wood to the mill and when harnessed to turbines and generators, to furnish power and light.

Conclusions.

The development and increased production in the manufacture of paper calls attention to the question of the conservation of the wood supply. Each year tremendous quantities of wood are being

cut while fire destroys even more. Unless adequate conservation measures are taken, the pulp and paper industry will soon cease to expand owing to the lack of raw material.

The pulp and paper industry has done much toward the opening up of Northern Ontario. This has been largely due to the availability of plenty of cheap hydro power, since the cost of steam-power in this coalless area would be prohibitive.

The future trend of the industry will be northward with the depletion of more southern forest areas.

X. Concluding Comment

The mineral and forest resources of the "Area" have probably done more towards opening up Northern Ontario than any other agency, unless in this connection there might be mentioned the railways, many of which in turn have been the result of the development of these natural resources. In practically every case the exploitation of these natural resources has been coupled with and dependent upon the development of the readily available hydro power, until at the present day there is installed in the "Area" turbines totalling 296,821 h.p. It would be difficult to find a more striking illustration of the enormous asset which Canada possesses in her abundant supply of low priced hydro energy than that instanced in the relationship of water-power to the exploitation and utilization of the other resources in the "Area" embraced in the scope of this report.

LIST OF REFERENCES

[1] See page 14, Water Resources Paper No. 33, Central Electric Stations in Canada, by J. T. Johnston, C.E.

[3] The power figures used here were secured from data of the Dominion Water Power Branch.

[4] Page 1, Bulletin No. 722, issued by the Dominion Water Power Branch.

[5] Table No. 2 supplied by the Dominion Water Power Branch.

[6] Table No. 3 compiled from data supplied by the Dominion Water Power Branch.

[7] Report of A. R. Webster, Inspector of Mines for Ontario.

[8] Page 183, Water Resources Paper No. 33, entitled, "Central Electric Stations in Canada," by J. T. Johnston, C.E.

[9] Page 283, Water Resources Paper No. 33, entitled, "Central Electric Stations in Canada," by J. T. Johnston, C.E.

[10] Page 182, Water Resources Paper No. 33, entitled, "Central Electric Stations in Canada," by J. T. Johnston, C.E.

[11] Page 15, Water Resources Paper No. 33, entitled, "Central Electric Stations in Canada," by J. T. Johnston, C.E.

[12] Page 1, Bulletin No. 722, issued by the Dominion Water Power Branch.

[13] Page 7 of "Mines and Mineral Resources", issued by the Ontario Department of Mines.

[14] Dates and information from Page 12, of booklet entitled, "Mines and Mineral Resources," issued by the Ontario Department of Mines.

[15] Page 13 of above-named booklet.

[16] Page 14 of booklet entitled, "Mines and Mineral Resources," issued by the Ontario Department of Mines.

[17] Page 9 of above-named booklet.

[18] Pages 30 and 31 of booklet entitled, "Mines and Mineral Resources," issued by the Ontario Deparmtent of Mines.

[19] Page 31 of above-named booklet.

[20] Page 37 of above-named booklet.

[21] Page 40 of above-named booklet.

[22] Page 48 of booklet entitled, "Mines and Mineral Resources," issued by the Ontario Department of Mines.

[23] Page 41 of above-named booklet.

[24] Page 4 of Bulletin No. 733 issued by the Dominion Water-Power Branch.

[25] "Montreal Star," September 29, 1923, by Alexander Gray.

[26] Page 1 of Bulletin No. 731, issued by the Dominion Water-Power Branch.

[27] Page 26, of booklet entitled "Lands and Forests of Ontario," issued by the Ontario Department of Lands and Forests.

[28] Page 473, "The Engineering Journal," July, 1924, by R. W. Leeper.

[29] Page 1, Bulletin No. 731, issued by the Dominion Water-Power Branch.

[30] Data secured from the Dominion Water-Power Branch.

[31] Data secured from the Dominion Water-Power Branch.

[32] Data secured from the Dominion Water-Power Branch.

[33] Page 138, Pulp and Paper Magazine, January, 1924.

ENGINEERING SOCIETY STORE

The Year Book

of the

University of Toronto Engineering Society

Faculty of Applied Science

1925

DANCE COMMITTEE

R. A. Fisher R. B. Rochester R. E. Taylor

T. W. Jackson, J. F. Millican (Pres. Eng. Soc.), W. I. Turner (Chairman), V. DeStrickland

The Engineering Society Annual Dinner

It seems to be a terrific task these days to make a Schoolman understand that when he attends a School dinner his invested capital equals value received.

The School Dinner performs the great function of getting the whole School and Faculty together at the festive board and making merry. Its intangible value is priceless and it leaves memories that are indelible throughout the years after graduation.

The 35th Annual Dinner was held at Hart House, Wednesday, November 21st. The menu put forth by Hart House has never been excelled, including everything from soup to nuts. Between courses the School quartet and various entertainment kept everybody in a happy frame of mind, and we all had a very contented feeling by the time Frank Millican gave the toast to the King.

Dean DeLury, Prof. Bain, Prof. Loudon and representatives from McGill, Queen's and R.M.C. responded to the toasts to the University, the Faculty, the Profession, and the Sister Societies, which were given by George Crossgrove, Doug Turnbull, Ro Smythe and Monty Laughlin.

Prof. Haultain then introduced the speaker of the evening, the Hon. Mr. McCrea, Minister of Mines, who gave a most interesting talk on mining in Northern Ontario. This was illustrated by moving pictures which showed the vastness of the mining enterprise in our Province.

The dinner broke up at 11.30, and was pronounced by a professor who had been to at least the last twenty dinners, to be the best he had ever attended. It is hoped that the undergraduates will support the dinner better next year.

Many thanks must be given for the help and co-operation given by the committee, whose efforts made the dinner the wonderful success it was.

W. I. Turner.

The Engineering Society Annual At Home

Science has always had the reputation of holding the best University dances and this year's At-Home held in the Crystal Ballroom of the King Edward Hotel, Friday, February 13th, lived up to all expectations.

At 9 o'clock the guests were received by the patronesses and then amidst ideal surroundings were swung into a whirl of gaiety which, aided by Jardine's orchestra, a superb supper served in the Pompeian

DINNER COMMITTEE

V. B. Lillie C. A. Pollock L. A. Richardosn

V. DeStrickland, J. F. Millican (Pres. Eng. Soc.), W. I. Turner (Chairman), G. M. Crossgrove

Absent—A. D. Morton, J. W. Paerson

Room, and a well-balanced programme, made everybody so happy and hilarious that the dance had to be prolonged till 3 o'clock.

Due to the splendid co-operation of the committee all arrangements were carried out perfectly, and even the other faculties present pronounced the dance to be the best University dance of the year.

W. I. Turner.

School Night at Hart House

The third annual School Night was held at Hart House on January 30th. The way in which the staff, graduates and undergraduates turned out did much to make the evening a success, and reflects great credit on the School men and this function, which is rapidly becoming a School tradition.

Owing to the decreased registration in School the Engineering Society felt that it could not bear the drain of financing the function. By levying a charge of seventy cents per couple it was made to pay its own way. This charge included refreshments, as well as admission and in this way no loss was sustained through some of those present not buying supper.

The stupendous production in the theatre was extremely well received. By way of a change its theme was a deep dyed mystery, with cold crime, tempered by a hot love.

The outstanding figures in the play were: "Art" Toye as our hero Square Jerry, "Doug" Turnbull as the villainous Sleek Greek, and "Russ" Monnel and "Spike" Sullivan as Sherlock Holmes and Watson respectively.

Much credit is due "Spike" Thompson and his crew on the lights.

This atrocity was written, produced, directed and staged by Ralph S. Kerr, author of Insomnia, who also played the leading feminine role.

Several popular and capable artists were obtained for the programme in the Music Room, who, along with the Hawaiian group of the S.I.C., provided a very interesting and enjoyable entertainment.

The executives of the clubs and three upper years filled the common rooms and corridors with side shows, slight-of-hand artists, wandering musicians, and what-nots. The crowd literally thronged every nook and crannie, and as they seethed and eddied about the points of interest the inner man was forgotten. Lolly-pops, chocolate bars and horns were rained gratuitously upon the mob and helped to create an atmosphere of jollification.

The Tank was reserved for a laughing and swearing room, where the crowd rested as they watched the aquatic endeavours before again breasting the tide.

The Chemicals provided punch and Eskimo pies in a secluded alcove for a nominal fee.

Dancing commenced in the Big Gym and Great Hall at ten o'clock and the crowd drove their dogs around till the witching hour, one o'clock. A good time was had by all.

One hundred and fifteen School men shared the responsibility and work of the evening, and the Committee welcomes this opportunity to express its appreciation of their very able assistance and the co-operation of the staff of Hart House.

J. F. Tanton
R. S. Kerr

Engineering Society Election Results

President ..... Doug W. Dow
1st Vice-President ..... Don C. Beam
2nd Vice-President ..... W. H. M. Laughlin
Treasurer ..... T. B. Smith
Secretary ..... A. A. Somerville
Curator ..... W. A. Duncan

Chairmen of Clubs

Civil Club ..... W. H. Kribs
M. & M. ..... A. D. Dickson
M. & E. ..... C. E. Nugent
Architectural ..... H. M. McLaughlin
Chemical ..... J. D. Hawken
Debating ..... E. G. Davies

Athletic Association

President ..... C. A. Morrison
Vice-President ..... J. H. P. Russell
Secretary-Treasurer ..... H. P. Ruggle

Year Executives

Fourth Year—

President ..... E. R. Complin
Vice-President ..... C. H. McGuire
Secretary-Treasurer ..... C. W. Witherell
Athletic Representative ..... G. R. Rumble

Third Year—

President ..... R. B. Rochester
Vice-President ..... J. K. Gardner
Secretary-Treasurer ..... C. A. Parkinson
Athletic Representative ..... G. L. B. Roberts

Second Year—

President ..... J. M. C. Lazier
Vice-President ..... A. B. Hunt
Secretary-Treasurer ..... S. W. S. Hall
Athletic Representative ..... A. M. Grant

S.A.C. Executive

President ..... J. B. Beck
Vice-President ..... R. P. Quance
Secretary-Treasurer ..... D. S. Laidlaw

2T5 Permanent Executive

President ..... J. F. Tanton
Vice-Presidents ..... J. W. Kennedy
J. F. Millican
G. M. Crossgrove
Secretary-Treasurer ..... A. D. Morton

School Representatives on Hart House Committees

House ..... W. H. M. Laughlin
Hall ..... R. E. Smythe
Library ..... E. G. Davies
Music ..... C. A. Pollack
Billiard ..... P. Wigle
Sketch ..... J. M. C. Lazier

Permanent Executive Classs '25

J. F. Tanton, *Pres.*

J. F. Millican, *Vice-Pres.*

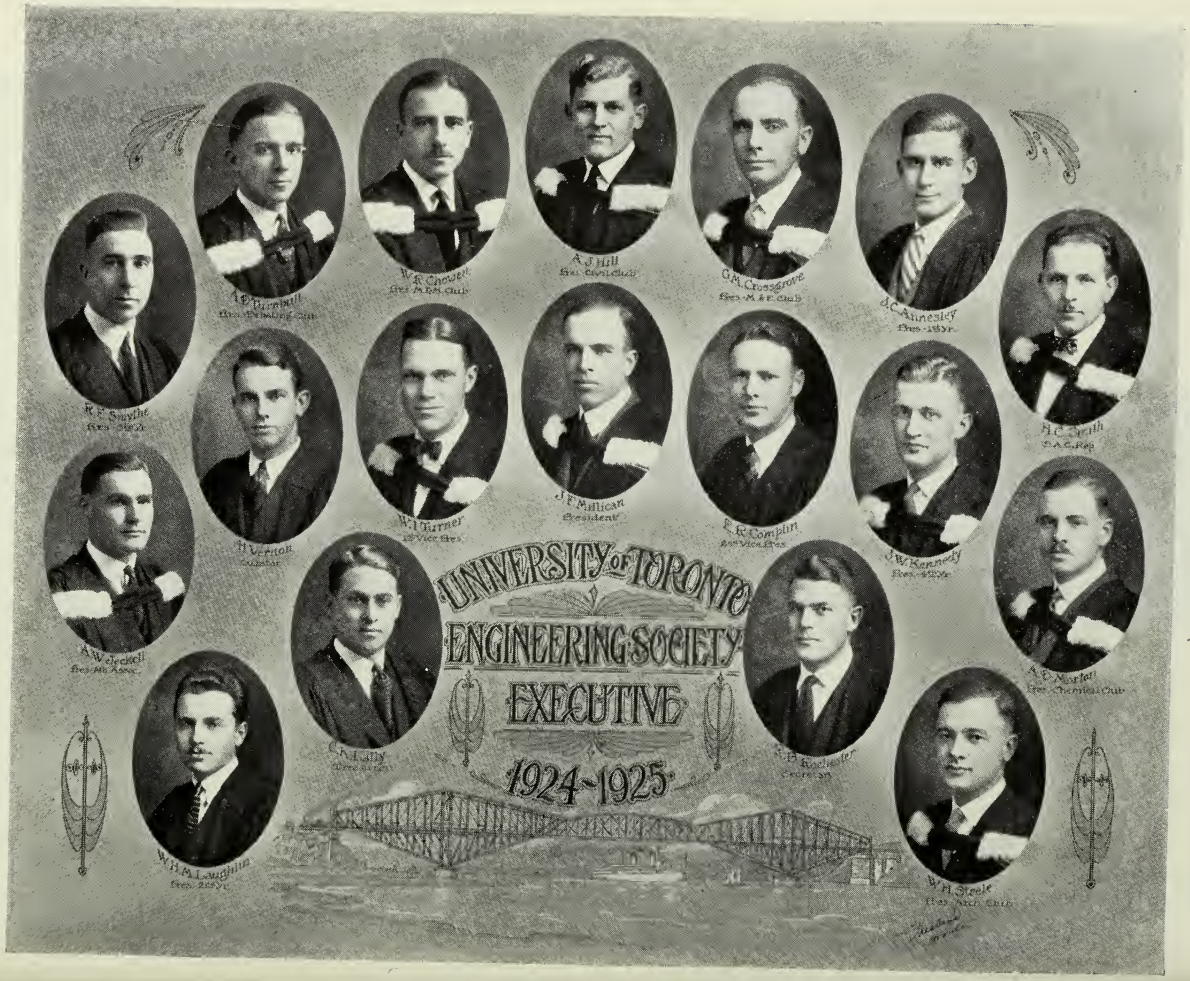
J. W. Kennedy, *Vice-Pres.*

C. M. Crossgrove, *Vice-Pres.*

A. D. Morton, *Sec.-Treas.*

It is the sincere desire of the Permanent Executive of the Class of 2T5 that the members of this Year make every effort to keep closely in touch with each other. In this way the wonderful class spirit which has been evinced the last four years will stay with us until "death do us part", and will enrich the memories of the time spent in the old Red School House. The secretary hopes that all members of the Year will find time to correspond regularly with him and especially requests that he be notified as soon as possible of permanent addresses and subequent changes.

The Executive take this opportunity of wishing the utmost of health, prosperity and professional success for all members of Science 2T5.


UNIVERSITY OF TORONTO
ENGINEERING SOCIETY
EXECUTIVE
1924-1925
R. E. Smythe
Pres. Sec'y.
A. P. Burnhill
Pres. Plumbing Club
W. R. Chewett
Pres. M. & M. Club
A. J. Hill
Pres. Civil Club
G. A. Crossgrove
Pres. M. & E. Club
J. C. Ainnesley
Pres. 1st Yr.
H. C. Smith
S. A. C. Rep.
A. W. Leckie
Pres. Ath. Assoc.
H. Vernon
Curator
W. J. Turner
1st Vice Pres.
J. F. Mullican
President
E. R. Compton
2nd Vice Pres.
J. W. Kennedy
Pres. 4th Yr.
A. E. Morton
Pres. Chemical Club
C. A. Lilly
Treas. Assoc.
R. B. Rochester
Secretary
W. H. M. Laughlin
Pres. 2nd Yr.
W. H. Steele
Pres. Arch. Club

The Mechanical and Electrical Club

In reviewing the activities of the Club for the School year 1924-25, the outstanding point seems to be the degree of success which has attended the attempt of the Executive to win back a little of the technical side of the Club's mission. To maintain the high social position attained by our predecessors, and yet enlarge the scope of the Club's activities in this manner, seemed a tremendous step at the outset, but the results have been most gratifying and augur well for the future.

The first shot in this new campaign was fired when the Executive approached both the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, requesting them to run Student Papers' Competitions, open to members of the Club. This they readily consented to do. Both these competitions were carried through to successful conclusions, two prizes being awarded in each case. The Mechanical prizes were awarded to Messrs. F. W. Watson and T. C. Graham, Fourth Year, Dept. 3, and the Electrical prizes to Messrs A. H. Frampton and B. C. Griffith, Fourth Year, Dept. 7. Both Associations held Student Meetings, at which the winning papers were presented by their authors. The success of this enterprise warrants its further trial, and bids fair to make it an annual event.

The second shot took the form of an attempt to organize weekly technical meetings of the Club, at which members would present their own papers. So far, it has not been found feasible to hold general joint meetings, but highly successful meetings of this character have been held from week to week in the separate Mechanical and Electrical Departments of the Fourth Year. These meetings have received the heartiest approval and support of the Faculty, in fact, their co-operation has been wholly responsible for the complete success of this venture. The quality of the papers presented, and of the subsequent discussion, warrants the continuation and expansion of this phase of the Club's activity.

In addition to these meetings, several general meetings of the Club were held, at which addresses were given by prominent engineers. Outstanding among these were return visits of our friends, W. J. Davidson and Kettering, of the General Motors Corp. The reception accorded these men was certainly phenomenal, the large lecture room in the Mining Building being packed at each meeting.

While not exactly a technical meeting the return visit of our friends, the "Hello Girls," must be recorded, as that event also drew a "packed house." The kindness of the Bell Telephone Co. was responsible for the success of this meeting, though some of the boys wondered who was responsible for the "nawsty" knocks they received during the demonstration.

And now to record a little of the social side of the year. The first outing of the Club was the annual trip of inspection to the Niagara power plants. The party, numbering approximately 90, and accompanied by Prof. Angus, to whom the complete success of the trip was due, left Toronto on the early morning boat, arriving in due course at the Queenston Generating Station. To the credit of the Hydro men, who acted so efficiently as guides, nobody was lost during the inspection of the seemingly vast expanse of the plant, and all assembled on the top floor for lunch, which was served by our erstwhile guides. The afternoon was spent at the canal intake at Chippawa, and at the Ontario Power Co.'s intake and plant, below the Falls. After a truly profitable visit the party left Queenston on the evening boat, arriving in Toronto with voices somewhat diminished by much impromptu entertaining on the homeward trip.

Shortly after this trip we again embarked on the early boat, this time bound for the American metropolis of Buffalo. Special cars were attached to the Lewiston-Buffalo express (?), and all the party—numbering about 160—arrived at our destination O.K. We were cordially received by the Buffalo Board of Trade, who entertained us at lunch, and we spent the afternoon visiting such plants as the Steel Co., Pierce-Arrow Motors, steam plant of the Buffalo G.E. Co., and radio station WGR. Once again the evening boat carried us (and, at least, two packages of American cigarettes) back home.

Two other general trips were arranged, both within the city. The first was to the repair shops of the Transportation Commission at Hillcrest Park, and the other to the Adelaide and Grover Exchanges of the Bell Telephone Co.

It was also the intention of the Executive to carry out the idea of a dinner, as was so successfully done in 1922. However, an unfortunate clashing of dates, after all arrangements had been made, resulted in its indefinite postponement. We must, therefore, leave this idea with the incoming Executive.

This somewhat disconnected account of the year's activities would not be complete without mention of the splendid spirit of co-operation between the Executive and the members of the Club. The success of these new ventures are sufficient testimony and speak well for the future of what we feel proud to call, the best Club in School. In handing over the reins of office to the incoming Executive, we can only say "Good luck."

George Crossgrove, President.

H. T. Pritchard
1st Yr Mech Rep
J. R. Gardner
2nd Yr Elec Rep
F. W. Watson
2nd Vice Chairman
J. E. Howell
2nd Yr Mech Rep
J. H. F. Russell
1st Yr Elec Rep
C. H. McGuire
3rd Yr Rep
G. M. Crossgrove
Chairman
Prof. R. W. Angus
Hon. Chairman
A. H. Frampton
1st Vice Chairman
C. E. Nugent
Secy Treas
MECHANICAL AND ELECTRICAL CLUB
EXECUTIVE
FACULTY OF APPLIED SCIENCE
1924 - U. of T. - 1925
Asst. Prof. A. R. Zimmer
Hon. Vice Chairman
Asst. Prof. J. H. Larkin
Hon. Vice Chairman

The Mining and Metallurgical Club

We've heard about Mechanicals and Chemicals enough,
The Civils and Electricals they, too, have hung a bluff;
Now, let us hear about the boys who make the going clear,
The good old Metallurgists and the Mining Engineers.

The Miners hit the backwoods trail in weather, foul or fair,
And in the stopes and drifts blast out the good stuff buried there,
They face the dangers underground, without a thought of fear,
I guess you have to hand it to the Mining Engineer!

And what becomes of all the precious rock that they dig up?
The metallurgist transforms it from muck to silver cup.
He makes the rails to carry all your trains from far and near,
The king-pin of the others' crafts, the Metallurgical Engineer.

"Si Derite".

"We are miners seeking riches, . . . !" Propriety forbids the rest of the famous yell, but if you want to hear it, place your ear at the keyhole when the boys are in stag session and your curiosity will be satisfied. Other places might be mentioned too, but our theme cries for utterance, so we must proceed.

The first general meeting of the Club was held in the form of a Smoker in Hart House during the last week of October. This meeting is the most important one from the point of Club business of the year, since at this meeting the election of Vice-President, Secretary-Treasurer, and year Reps. takes place, as well as any other business requiring attention. On this occasion these important details were accomplished in spite of much noise and loud cheers, mainly emanating from one, Spike Sullivan, who, fortunately for the patience of the presiding gentleman, at half time felt a little upset gastronomically and retired with some precipitancy, volubly cursing these vendors of bottled T.N.T. Next came the initiation of our newly admitted members, the Freshmen. The ritual of this procedure cannot be made public, so it must be passed over with an apparent lightness, which is far from depicting its actual importance. Then the evening being well advanced, Mr. "Fat" Dickson, the newly elected Secretary-Treasurer announced the fact that lunch was prepared and waiting, so without

Top Row: R. L. Piper (III Year Metallurgy Representative), F. A. C. Shaw (IV Year Metallurgy Representative), L. M. Browne (IV Year Mining Representative), J. P. Dick (III Year Mining Representative,)T. B. Smith (II Year Representative).
Bottom Row: A. D. Dickson (Secretary-Treasurer), W. R. Chowen (Chairman), J. E. Pearen (Vice-Chairman).

loss of time, but with proper grimness and fortitude the members assailed this the last act on the programme.

Thanks to the efforts of Mr. Ernie Pearen, the Vice-President and Mr. Dickson, in November, it was the privilege of the members to enjoy a very satisfactory dinner and a most interesting speaker, the latter being Mr. Balmer Neilly, the secretary and a director of the McIntyre Gold Mines Ltd. Mr. Neilly being a grad. of School of '07 and with a vast experience in our own northern mining fields gave an address which, though delivered in a most engagingly humorous vein, carried with it a wealth of advice and instruction, which will long remain with each member. It was with sincere delight that the executive noted the support of the members of the Faculty by their presence there that evening.

In January a very interesting informal address was given by Mr. Dorfman, consulting engineer for the Huronian Belt Corp., on some of the problems met with in cyanidation, to the senior members of the Club. This subject proved of great interest and opens up a very definite field for research. Prof. Guess is to be sincerely congratulated on his obtaining so instructive a speaker for the senior members of the Club.

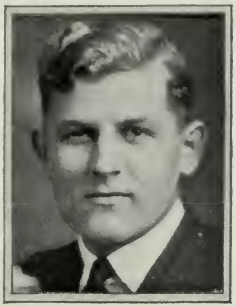
The next meeting of the Club, in form, was an entirely social one. On February 18th, an informal dance was held in the Blue Bird Inn, which passed off most successfully. The Gull Lake Orchestra furnished the music and made some at least of those present recalled, with a little sadness for the joys that have passed, the happy days spent around that spot.

The last meeting of the Club was held in C-32 on Thursday, March 5th. At this meeting, the candidates for the Presidency of the Club for the coming year were given the opportunity of speaking. Candidates for other positions in the Engineering Society seeing this opportunity to present themselves before the members, also spoke, so that the net result was a very interesting and even instructive exhibition of oratory.

The very hearty appreciation of the executive of the Club goes out to Mr. L. M. Browne, Chairman of the Entertainment Committee and his committee for their unstinted efforts in that side of the Club activities. In addition, the executive wish to express their gratitude to those members of the Third and Fourth years who so ably and unselfishly gave of their time and energy to the successful consummation of the Club stunt on School Night.

And now with infinite hope, best wishes and unlimited faith in the future well-being of the Club under the guidance of Mr. "Fat" Dickson, the President for the coming year, we will now "drive" for awhile.

W. R. Chowen.



The Civil Club

The School elections are over; they are a stern reminder that time is drawing nigh. For some of us this is the last time (at least we hope it is).

This year the Club swung into activity on October 30th, with a trip to Oshawa. Here the General Motors Plant was inspected from start to finish. The coming engineers learned something of big scale production, efficiency and plant organization. The party was divided into small groups, each group having a School Grad acting as a guide. This proved very profitable. Before finally leaving the plant each member was presented with a handsome booklet, published by the General Motors people, and called, "Canada as a Builder of Motor Cars".

On January 27th, 1925, the members assembled in Hart House for a very successful smoker. The evening turned out to be a high-class musical gathering. Songs were run off in rapid succession, the music being supplied by a "Gull Lake" orchestra. Messrs. Potter and Teagle did their "stuff", to the amazement of the rest of the members. Professors Gillespie and Young recalled some amusing stories of the late Dean Galbraith. Then Mr. Ben Hokea appeared, and immediately captivated everybody with his playing and singing.

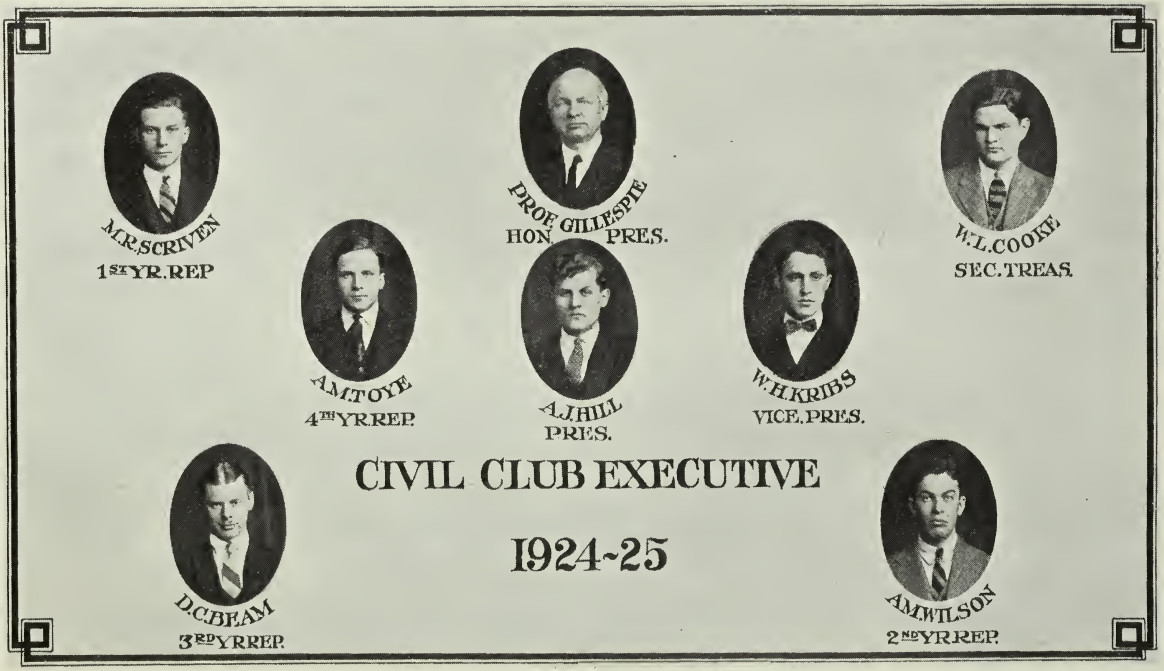
The smoker was finally closed with the customary eats and yells.

The Club was not addressed by any members this year, as it was felt that we get enough technical matter from the Professors.

Nothing but praise can be given to the members on the executive, who have given unsparingly of their time and energy to make the Civil Club a live wire.

The incoming chairman is a man full of ideas, energy and experience, who will do everything to make the Club a success. To Mr. Bert Kribs I pass the bucket.

A. J. Hill, President.


M.R.SCRIVEN
1st YR.REP
PROF GILLESPIE
HON. PRES.
W.L.COOKE
SEC.TREAS.
A.M.TOYE
4th YR.REP.
A.J.HILL
PRES.
W.H.KRIBS
VICE.PRES.
CIVIL CLUB EXECUTIVE
1924-25
D.C.BEAM
3rd YR.REP.
A.M.WILSON
2nd YR.REP.

The Industrial Chemical Club

Chemical Club activities for the year began with a smoker at Hart House. After the First Year members had introduced themselves the election of officers was held and resulted in the following: Hon. Pres., Prof. J. W. Bain; Vice-Pres., J. D. Hawken; Sec.-Treas., W. M. Scarth; Curator, G. L. Andrew; Year Reps., R. S. Kerr, C. W. Witherell, R. E. Richardson, C. F. Burk. Short interesting addresses were given by members of the Club: Messrs. Coppin, Jeffrey and Ryan. The evening was enlivened by a fistic encounter between Terrible Toy and Battling Hubbard.

A week later an expedition sallied forth to inspect industries. The trip included The Lincoln Paper Mill Co. and The Interlake Tissue Mills at Merritton and the Hooker Electro-Chemical Plant at Niagara Falls, New York.

At the November meeting a very interesting illustrated address was delivered by Mr. E. T. Sterne, B.Sc., on the subject of Sodium Silicate. The smoker was preceded by two inter-year baseball games, from which the Fourth and the First Years emerged victorious.

The annual Fall Dinner was held in December at the Prince George Hotel. Professor E. G. R. Ardagh spoke on the subject of Chemical Literature, and Dr. "Bob" Stuart told of his experiences as a medical man in the Canadian Arctic Regions. Prof. Bain supplemented Dr. Stuart's address by some very interesting remarks on early Canadian explorations. Ralph Kerr concluded the evening with a remarkable recitation of the doings of "The Hermit of Shark Tooth Shoals."

At "School Night" the Chemical Club assisted by selling refreshments during the whole evening and incidentally enriched the coffers of the committee to an extent that enabled them to break even on their expenses.

The February meeting was held jointly with the Arts Chemical Club. Moving pictures were shown on "Gold Mining," "Silver Extraction" and "Pulp and Paper." Prof. J. L. Rogers gave a highly interesting and instructive talk on the subject of Toxicology.

The annual nominations produced a three-cornered fight for

Top Row: C. W. Witherell (III Year Representative), G. L. Andrew (Curator), C. F. Burke (I Year Representative), R. E. Richardson (II Year Representative).

Bottom Row: R. S. Kerr (IV Year Representative), Prof. J. W. Bain (Hon. President), A. D. Morton (President), J. D. Hawken (Vice-President), W. M. Scarth (Secretary-Treasurer).

the position of Chairman of the Club. The election resulted in a tie, making necessary a by-election in which Mr. Hawken eliminated Mr. Jeffrey.

The final "bust" of the year was the annual Banquet held at the Prince George. The time-honoured Dewar Flask was presented, and the members then entered into a heated discussion of various timely topics. After proper thanks were rendered for the support given the Club by its members of the past year the meeting was turned over to Mr. J. D. Hawken, the chairman-elect, with best wishes for future success.

A. D. Morton, Pres.

Architecture

Although the Architectural Club does not loom very large among School activities as a whole, it is nevertheless a very vital part. Owing to its small size, however, and the different nature of its curriculum it may seem a little exclusive.

This year the executive guiding its tender existence consisted of, President, W. H. Steele; Vice-President, J. Ryrie; Secretary, Miss E. M. Lalor; Treasurer, J. D. Mathews; 3rd Year Rep., M. H. Johnson; 2nd Year Rep., R. S. Hanks; and 1st Year Rep., J. M. Mathers.

The first meeting of the Club was a dinner at the Five Sisters' Tea Room. Mr. Molesworth, whom we were very fortunate to have as Honorary President of the Club, in a short address brought home to the members a keen feeling of their relationship with the members of the profession and an appreciation of the work done by the Ontario Association of Architects. Following this was the initiation of the freshmen, which proved very amusing. Each one of them was forced to give an impromtu speech on some trivial subject chosen by their well wishing sophomores.

Later in the year the Club held an afternoon meeting in the School. Mr. A. H. Gregg gave a very interesting talk on office management.

The last meeting of the year took the form of a dinner at the Nora Tea Rooms. Mr. J. P. Hynes spoke on the Ethics of the Profession. A very interesting discussion followed.

Top Row: I. D. Matthew (Treasurer), R. S. Hanks (II Year Representative), M. H. Johnson (III Year Representative), J. M. Mathers (I Year Representative).

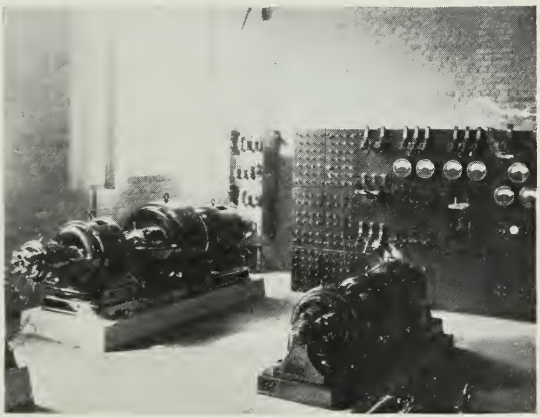
Bottom Row: Jack Ryrie (Vice-President), Harland Steele (President), G. N. Molesworth (Hon. President), H. H. Madill (Graduate Representative), Miss E. M. Lalor (Secretary).

The senior members of the club were fortunate in having a tour of inspection of the Toronto Brick Companies' factories after being entertained at luncheon by the officials of the company. A trip to the McGregor-McIntyre's steel plant was also very profitable. Much credit is due Professor H. H. Madill, who was instrumental in arranging these trips.

On April 4th the Club held its annual exhibition in East Hall of University College. The exhibition was opened by Mr. Vincent Massey. The work of the undergraduates of the course, those taking post-graduate work, and the work of some of the graduates who are now practising, was displayed.

To help stimulate interest in Architecture, by bringing before the public some of the work done by this Department, space has been reserved for a display at the Canadian National Exhibition.

E. M. Lalor, Secretary.



The Debating Club

If a School man would be another Demosthenes he comes out to the meetings of the Debating Club and there, since no real sea is present, orates to the sea of faces. If he has no pebble handy he uses a life-saver.

All authorities, including the present fourth year, agree unanimously that the ability to speak clearly, convincingly, in a manner pleasing to the ear, adequately but not verbosely, is of very great value to anyone who aims to become more than a mere pencil pusher. The ability to think lucidly when on one's feet, and to express those thoughts in suitable language comes only with practice. It is only by practice that a man acquires self confidence and self control, freedom from nervousness and a knowledge of the psychology of audiences.

It has been the function of the Debating Club to provide all comers with this practice. It is probably unnecessary to state that it has been the custom for the club to hold weekly meetings between 5 and 6 p.m. in Hart House. One member introduces some subject in a 5 minute speech, and each man present then gives his views. It is our firm belief that this is the best way to teach the unwilling tongue.

In the Inter-College debating series, Messrs. T. B. Smith and W. G. Raymore of 2nd year debated Dents. The subject was—"Resolved that the increased complexity of modern life due to improved means of transportation and communication is detrimental to the welfare of the human race". School lost after a close debate.

On March 12, the club held its annual Oratorical contest. Three prizes, of value $5, $3, and $2, were given to those taking 1st, 2nd and 3rd respectively. The winner also had his name engraved on the Engineering Society Cup. The contestants gave five minute impromptu speeches on subjects which were drawn at the beginning of the evening. Mr. R. B. Rochester of 2nd year won first, followed closely by Mr. H. Miller, 4th year, and Mr. E. G. Davies, 3rd year, for the honours. The judges were Prof. Haultain, Honorary President of the Club, Prof. Gillespie and Prof. Young.

The officers for the year were:—Hon. President, Prof. H. E. T.

Top Row: V. G. Loscombe (I Year Representative), G. L. Delplante (II Year Representative), H. D. Griffith (III Year Representative).

Bottom Row: N. E. Macpherson (IV Year Representative), A. D. Turnbull (President), Prof. H. E. T. Haultain (Hon. President) J. H. Ings (Vice-President), E. T. W. Bailey (Secretary-Treasurer).

Haultain; President, A. D. Turnbull; Vice-President, J. H. Ings; Secretary-Treasurer, E. T. W. Bailey; 4th Year Rep., N. M. Macpherson; 3rd Year Rep., H. D. Griffith; 2nd Year Rep., G. L. Delaplant; 1st Year Rep., V. G. Loscombe.

Next year the work of the Club will be ably carried on under the direction of Mr. E. G. Davies, and we trust that he will have excellent support.

DOUG. TURNBULL, President.

MEMORIAL TOWER

2T5

We, the class of 2T5 have at last come to the parting of the ways, where each must decide "whether to endure the ills we know or fly to others that we know not of". We are the ones who pass on and in passing leave behind us our contributions to those traditions which will ever bind School and Schoolman.

This, our final year, has eclipsed in every way the record attained in the past three years. Perhaps this has been due partly to a frantic desire on our part to get as much enjoyment as possible before it was too late and partly to a certain feeling of relief that mounts higher as each successive year is safely surmounted and put away as history. Be that as it may, the fact is that everything from the smallest inspection tour to the Grad. Dance has been supported fully and whole heartedly.

Shortly after opening in the Fall, the year smoker was held in Hart House, the entertainment being provided by "local talent", with the added attraction of a few Gull Lake songs.

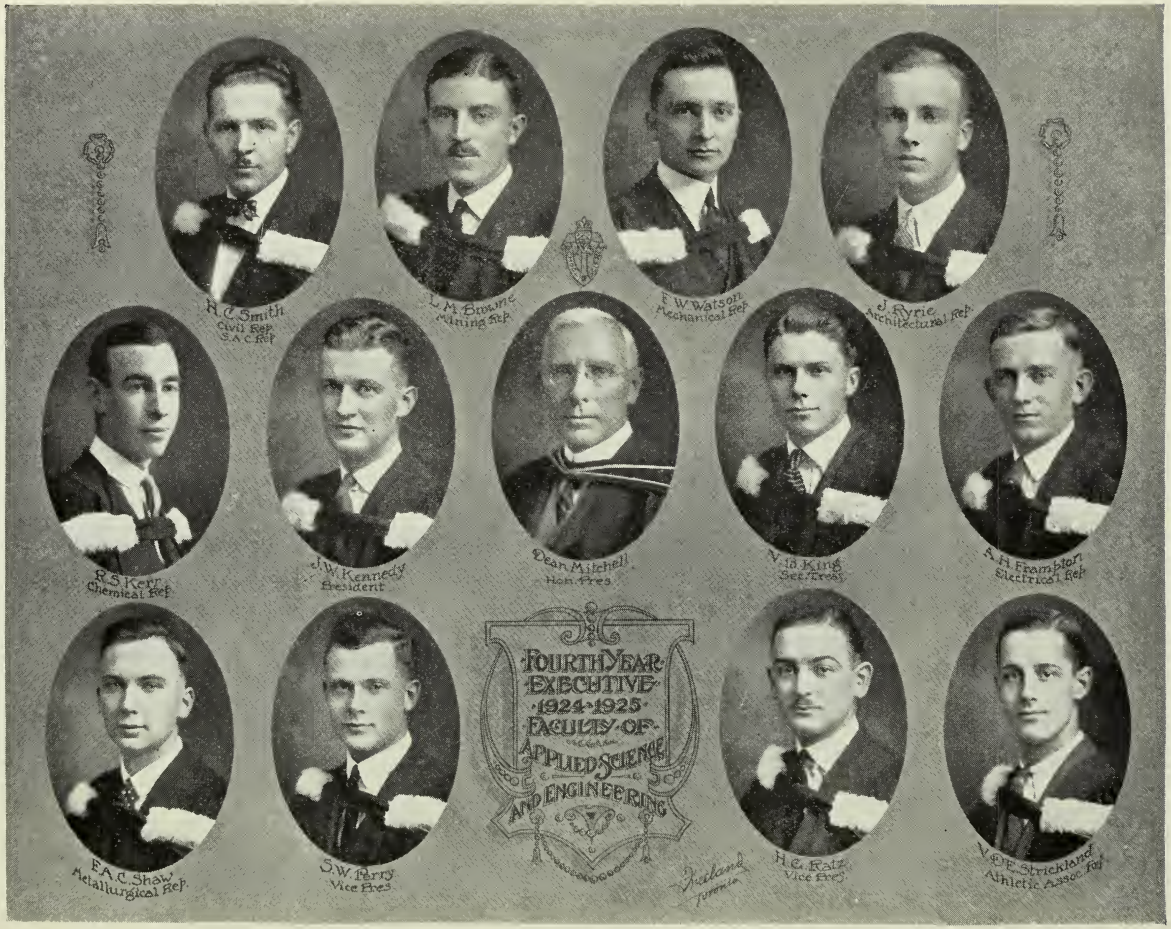
The combining of the 3rd and 4th year informal dances into Senior School Dance was carried out again this year. This function was held at the Palais Royale, November 5th, and was a complete success.

Amongst the reforms and numbers that we call "our own" was a theatre night, (admittedly not a new idea, but at least a revival) which, from the ticket demand, has not lost favour.

Weekly discussion groups were commenced, at which the members of the class provided the chairman, the speaker and the subsequent discussion. This idea, which was started by the M. & E. Club, was really an experiment, but has proved an unqualified success and, it is hoped, will become part of the curriculum.

Undoubtedly our greatest triumph was the Graduation Dance, held in the King Edward on February 27th. The dancers of the year were out in full strength, and reinforced by over twenty of the grads, our farewell dance was triumphantly written into the annals of time.

Each year there is a feeling prevalent that with the passing on of the senior men School's part in activities will be diminished. The old School spirit never fails, however, and we are justly proud of the honours brought to our year by the men who have engaged in the various activities. The indoor baseball, senior basketball and senior hockey teams have been composed mainly by men of the year. Senior School hockey team, under Capt. Bill. Strickland, brought the Jenning's Cup back to School, and playing as Varsity Intermediate representatives, lost the Intercollegiate Championship to McGill by one Goal. By Senior School winning the Jenning's Cup and Junior


R. C. Smith
Civil Rep.
S.A.C. Rep.
L. M. Browne
Mining Rep.
E. W. Watson
Mechanical Rep.
J. Kyrie
Architectural Rep.
R. S. Kerr
Chemical Rep.
J. W. Kennedy
President
Dean Mitchell
Hon. Pres.
N. B. King
Sec./Treas.
A. H. Frampton
Electrical Rep.
FOURTH YEAR
EXECUTIVE
1924-1925
FACULTY OF
APPLIED SCIENCE
AND ENGINEERING
F. A. C. Shaw
Metallurgical Rep.
S. W. Perry
Vice Pres.
H. C. Katz
Vice Pres.
V. P. E. Strickland
Athletic Assoc. Rep.

School the Mulock Cup, both trophies have come back to School in the same year, for the first time in twenty-one years.

Realizing that we cannot mention all who have been active throughout the year we would like to make a few acknowledgements of help from men not on the executive. To Harry Miller goes the entire credit for the Torontonensis work, which he has handled in a most efficient manner. George Crossgrove has been a staunch worker in the interests of the year, and ever ready with help and advice.

Our future existence as a year has been placed in the hands of the permanent executive, under the capable leadership of Jake Tanton, who will, no doubt, receive the support which has made this year the success it has been.

As we leave School, our feelings are a mingling of anticipation and regret. For four years we have been not only studying engineering—but forming associations that cannot be obtained elsewhere, and which will be ours for life, and we feel that we have acquired an education that enables us to face the future with confidence.

J. W. Kennedy.

Graduating Dance

Friday, February 27th, 1925, will suggest nothing to millions of people in this world, but to the men of '25 that day will always suggest thoughts of a never-to-be-forgotten party. Other days, and other parties, will stand out vividly in a four-year sojourn at School, but that day will always be the day of the Graduation Dance, and as such must go down in history with us.

For this, our greatest party, the Crystal Ballroom of the King Eddie was chosen, with a peppy musical O.C. Such a combination of harmony and harmonious surroundings is hard to beat at any time, but coupled with that mysterious feeling of reckless gaiety which is always associated with the Grad. Dance, the ensemble cannot be adequately described in ordinary language.

No attempt was made to provide decorations in the ballroom, as it is, at all times, outstanding in its crystal simplicity. Over the balcony was installed a creation of T. H. Wells, of our Architects, which depicted a somewhat weary Red Schoolhouse kicking an entirely startled 2T5 out into the arms of a cold, unsympathetic world. The inference was obvious and provided considerable amusement, even among the Patrons, our worthy Profs.

Shortly before supper, a mysterious halt was called. A frantic announcer called for Messrs. Kennedy, Smith, White and Norman. Everybody wondered! The surprise was sprung when Prof. Loudon came forward and made a presentation of a gold watch charm, embodying our year pin, to each one of them, our respective Prexies, as token of appreciation from the year.

Supper was served in the Blue Reception Room, the foyer, and on the balcony. These arrangements worked out even better than was expected, in that the tiring trip up and down the elevators was avoided and the intimate spirit of the party preserved. It was afterwards rumoured that several people lost front teeth providing music (?) on horns and whistles, but we cannot confirm this.

The elimination dance was featured by the distribution of driving harness and whips to each couple. Considerable amusement was caused by the attempts of fair drivers to subdue balky and restive steeds. The lucky reins-miss, Miss Jean Logie, received a 2T5 year pin, and the "prize horse", Mr. Eric Taylor, received the customary red ribbon.

The patronesses were, Mrs. C. H. Mitchell, Mrs. J. W. Bain, Mrs. T. R. Loudon, Mrs. A. E. Allcutt, Mrs. H. E. Haultain, and Mrs. A. R. Zimmer, and the gracious manner in which they entered into the spirit of the evening was a real honour to the year.

The Dance Committee are indeed to be complimented upon the excellence, and completeness, of the arrangements, which made this evening outstanding in our School life, so that all the evenings which are yet to come may be described as "nearly as good as the Grad. Dance!"

2T6

The third year of 2T6 was not uneventful but seems to have contained too many laboratory reports and briefs for the peace of mind and welfare of other endeavours.

As a get-together, a smoker was held in the first term, the class was practically all there, and spirit, School's most precious asset, was with them. The year orchestra excelled under Rex Complin's able guidance, the boxing staged by H. Griffith and L. Grime was most interesting, and the songs of Don Beam and Bert Kribs, both musical and comic. The most interesting part of the evening was no doubt in the flashes of wit and humour, together with the reminiscences spoken by Profs. Bain, Loudon, Young, Cockburn, Crerar, Parkin, and Smithers. More of this would be good for School.

The Senior School Dance and School Night were of the usual high type, and were pleasant diversions, the committees are to be congratulated.

Our year were not all present at the Annual School Dinner; this must be changed, this function must be supported above all others by every School man. It must be considered not only as a School function, but as a professional function.

Concerning elections, much may be written. Some of us have quietly wondered if a better nomination meeting could not be effected, if the meeting were of an orderly nature, and both nominator and nominee given an attentive hearing. Some offices now active may be growing obsolete, and it is at these meetings that candidates can be chosen intelligently.

This last election the year held a nomination luncheon at the Hotel Waverly, after a tasty repast, the provisional nominations were conducted in the following manner. Firstly, nominations received, secondly, withdrawals received, thirdly, nominations received, etc. With a large slate at the head table, changes were made until the very excellent list of candidates were chosen. By having nominations made spontaneously made at a meeting of this kind, it no doubt tends to run the most fitted men for office. Should not the practice of a candidate declaring his intention before nomination be abolished?

The executive wishes to thank the many members of the year who so ably served on committees for dances and "School Night", etc. They wish to express the appreciation of the whole class to those who led the way in athletics, and to Rex Complin and Kip Lally, who so efficiently aided the President in looking after the Society affairs.

We predict a better year next year, and hand over offices to Rex Complin (President elect), Clary McGuire (Vice-President), and C. W. Witherell (Secretary-Treasurer).

R. E. Smythe, President.

2T7

Exam time is with us again and members of the second year are taking things pretty seriously. However, after the year of great activity, both social and athletic, it will not hurt us to settle down and do a little concentrated studying.

With the first part of the Fall term our time was pretty well occupied in coercing the frosh, and by the time of their initiation they had all been reduced to a state of humble submission, due great success, and at this social function the freshmen were given entirely to the untiring efforts of our men. The initiation was a a large dose of real School spirit. No doubt this night will long be remembered by the freshmen as well as by the sophomores. After the initiation a social time was held in Hart House, at which the first and second year men had a chance of getting acquainted under ideal conditions.

The men of our year constituted the backbone of the Junior School rugby team, and at all games were well supported by a large body of second year rooters. In fact, lectures and labs were called off without hesitation, whenever a game was taking place.

Perhaps the largest and most important social function in which our year was closely connected was the Junior School Dance, held at Jenkins, at which over 200 couples, including first and second year and members of other years, were present. Dancing continued until two o'clock and everyone had a good time.

A very successful smoker was held at Hart House in the Fall, at which several members of the Faculty were present and told some very good stories. The year has been very active in athletics along all lines. At the present time we all hope to get over that great obstacle known as "Exams" with the minimum amount of sups and if all goes well we all hope to be together again next Fall.

W. H. M. Laughlin.

2T8

Last October 114 "engineers in the embyro" began their development. After the usual preliminaries, such as "Hats off" and "Ties out, frosh", the initiations took place in the old gym. It may be said that, though we were given a good riding, everything was taken in the right spirit. If there was any hard feeling it must have been removed by the excellent reception given us in Hart House the same night, and we departed feeling that at last we were accepted as brother Schoolmen.

The Annual Soph-Frosh Banquet took place at the Carls-Rite Hotel on December 2. The School Dinner, Junior School Dance, and the School At-Home were also big events of the year, and all received the hearty support of the freshmen. In addition, a very successful smoker was held in Hart House, Ben Hokea being the chief entertainer, while boxing, fencing and a sing-song all went to fill out an enjoyable evening.

In athletics 2T8 was represented on many teams, including Senior Intercollegiate rugby and hockey, Junior Intercollegiate rugby, Senior O.R.F.U., and Junior School rugby, hockey, rowing, baseball and basketball. Great credit is due 2T8 for their exceptionally strong numbers on the above mentioned Junior School teams.

On the track our men won the Inter-year Meet by an ample margin and did considerably more than their bit in bringing victory to School in the Interfaculty Meet.

Freshmen also took an active part in boxing, water polo, jolly old ruggah, rifle shooting, and gymnastics.

The class has very quickly caught the spirit of S.P.S. and the members have mixed well among themselves and the senior years.

If our academic work proves to be as successful as our athletics, then for 2T8 the auguries are good. But, as old Horace would have it—

"Aequam memento rebus in arduis
Servare mentem non secus in bonis
Ab insolenti temperatam
Laetitia. . . . . ."

Or in other words, "Be neither downhearted if things go wrong, nor over confident in success".

J. C. Annesley, President.

School Athletics, 1924-25

The School Athletic Association

As the years pass by it seems that we of School always appropriate a good fair share of the Interfaculty competitions. The past year has proved no exception in that, as we glance over the list, we see that six championships have been annexed, thus leading the Faculties in numbers. The results of the season show:

School—Rugby, Mulock Cup, Junior School; Hockey, Jenning's Cup, Senior School; Track, Outdoor, Lanky Rowell Cup; Indoor, Toronto Cricket Club Cup; Basketball, Sifton Cup; Rowing, no cup.

University College—Swimming, Fitzgerald Cup; Water Polo, Eckardt Cup.

Ontario Agricultural College—Soccer.

Medicine—Boxing, Wrestling and Fencing, Davidson Cup.

The winning of several of these, namely, the Mulock, Jenning's, and Sifton Cups, provided some exceptionally exciting final games, as the reports show..

Rugby during the past year was in favourable shape with Junior School proving the best of the series. We were represented on the Varsity teams in somewhat better numbers than during the past two years. On the Intercollegiate and O.R.F.U. teams we were represented by nine men, on the Intermediates by six men, and on the Juniors, who won the only Intercollegiate Rugby Championship of the year, by nine more. Only six of these are graduating, which should mean that School will soon be back to the days when these teams had a larger percentage than at present.

Hockey proved another bonanza when the Jenning's Cup finally found a resting place. This cup has been away for some time and as the team will be severely broken up by graduation, we hope that the team's successors will be able to retain it. This year Sr. School, as winner of the Jenning's Cup series, represented Varsity in the Intermediate Intercollegiate, and proved worthy contenders, although losing the finals against McGill by one point. All School men are justly proud of such a fine team.

For several years past, the School track team has proved invincible and as long as we have such men as Pollock, Morrison, McKenzie, Russell and others to carry on with, track trophies should find a permanent berth with us for some time yet.

This year no faculty or college can have any doubt but that School possesses the best of Interfaculty basketball material. With Junior and Senior School playing the final game for possession of

Top Row: G. B. Smith (II Year Representative), D. J. McKenzie (I Year Representative), C. A. Pollock (III Year Representative).
Bottom Row: C. A. Morrison (Secretary-Treasurer), A. E. Jeckell (President), Prof. T. R. Loudon (Hon. President), A. A. Somerville (Vice-President), V. D'E. Strickland (IV Year Representative).

the Cup the series has been well decided. Such a coincidence does not occur very often and when it does many of us do not realize the significance of it. The Cup should be well defended next season.

There is hardly any other sport indulged in with as much interest as rowing, the latest arrival to Interfaculty sport. Some credit for this may be attributed to the remarkable showing of the Varsity Senior Crew in the 1924 Olympics, but it is our guess that it is due more to the efforts of an untiring executive. This Association wishes the Rowing Club every success under their new constitution. Schoolmen have an enviable record to uphold in the Fall regatta and with the material on hand this should not be very difficult.

By now School should have learned the danger of not looking to the future at all times, but evidently not, for this happens to be the second year that swimming and water polo have suffered from lack of new men to fill the places of those who have passed on. To counteract this two teams were entered in the water polo schedule this year. Lack of entries in the swimming meet proved a handicap to point getting, so essential to winning a championship. A School swimming meet might remedy this and is certainly worth trying. This is not a lament because we haven't won, but represents the true state of affairs. It is high time we lifted the cups away from U.C. anyway.

After several years of vain struggling for a championship, the soccer club, feeling the strain of decreased registration influencing the calibre of their teams, believe a change would be beneficial. They suggest a first and second team, a plan which has some drawbacks, as a second team invariably suffers. A counter suggestion from the association as to a Junior and Senior play-off before the season, the best players to represent School in the Interfaculty series with one team has been made. This state of affairs has not been confined to soccer alone, as nearly every activity is feeling the same pinch. This will be one of the problems of the new executive next year.

The improvement shown by U.C. in the Senior Assault this year is what School, in the next few years, should strive to attain. At the start of a season we appear to have plenty of material, as evidenced by the School and Junior Assault, but what becomes of these men when the Senior takes place? Are they afraid to face the champions? If they only knew the champions worry more than they. School will be poorly represented next year if there is not a decided improvement. Loscombe in boxing, and Lee in wrestling, will be practically alone. Everyone should know how to fight, whether he has to or not, so why not more enthusiasm?

In indoor baseball the School teams this year were made up of men, most of whom were partaking in other sports. This is never

good policy, but under the circumstances seems inevitable, and explains our losses.

Interfaculty tennis has not yet become what it will in time attain. Efforts are being put forth by the U. of T. Athletic Association to provide suitable courts but until this is done, tennis does not appear to have a proper chance.

It is indeed pleasing to note the variety of athletic talent that 2T8 has produced. Duncan and Trimble of the Intercollegiate rugby team and Kirkpatrick of the Intercollegiate hockey team have already brought three first colours to the year's credit, while others look promising for next year. The championship Mulock Cup and Junior Intercollegiate rugby teams were composed largely of our worthy "Frosh". All in all, 2T8 has a fine record and deserves congratulations.

Of those graduating School is losing one real outstanding Interfaculty sportsman. E. M. (Tiny) Little has set a record for consistency and variety of endeavour worth mentioning. Those who have played with him know his qualities and to those who don't his record, which should be everybody's aim, follows:—

Basketball—1922, Sifton Cup Champions, 1923.
1924, Sifton Cup Champions, 1925.
Water Polo—1923, 1924, 1925.
Indoor Baseball—1922, 1923, 1924, 1925.
Hockey—1924, Jenning's Cup Champions, 1925.
Rugby—Mulock Cup Finalists, 1924.
English Rugby—Intercollegiate Champions, 1923, 1924, 1925.

To pick those most worthy of mention in Interfaculty sport is hard, but among others of 2T5 ranking high might be mentioned:

Cliff Booth for water polo, swimming, rugby.
Frank Millican (T) for track, rugby.
Warren Lloyd (T) for baseball, rugby, rowing.
Paul White for rugby, hockey.
Doug Turnbull (T) for track, harrier.
Ted. Hubbard (T) for boxing.
Bill Turner (T) for track.
Dave Lloyd for boxing, rugby.
Don Melick for soccer.
Spence Perry (T) for track, soccer.
Les Polack for track.
Fred Milne for soccer.

While of those to foster sport, George Smart (T), heads the list without peer.

During the year the executive have deemed it appropriate to grant 'S" to the following men:—

1924-25 "T" Holders

W. S. Kirkpatrick, 2T6, rugby.
N. G. Scott, 2T7, rowing.
R. A. Fisher, 2T6, rowing.
H. Vernon, 2T7, rowing.
F. A. Sievert, 2T7, rowing.

Soccer

F. J. Milne .
J. M. Milne.
J. W. Ryan.
A. H. Frampton.
J. F. Bridge.

Track

F. H. Vercoe.

Jr. School Rugby

Mulock Cup Champions
C. A. Parkinson.
J. A. Carrick.
C. A. McMartin.
W. D. A. Chisholm.
J. W. George.
A. M. Wilson.
R. B. Rochester, and rowing.
J. H. Fraser.

Sr. School Rugby

V. B. King.
G. B. Sullivan.
F. J. Wallis.

Rowing

R. M. Clark.
B. O. Heron.
W. U. Shaw.
A. J. Douglas.

Jr. School Basketball

A. G. Ballachey.
H. S. Irwin.
E. G. Willard.

Hockey

Jenning's Cup Champions
V. D. Strickland.
J. L. Johnson.
V. B. Little.
F. A. Sutton.
J. R. Auld.
A. E. Tuck.

Sr. School Basketball

E. G. Davis.
L. Grime.

General

A. C. Lee, wrestling.
A. J. Hill, swimming and water polo.
R. W. Teagle, indoor baseball.
R. E. Taylor, indoor baseball.
C. W. Dillane, hockey and baseball.

Freshmen 2T8

"T" Holders

W. A. Duncan, rugby.
H. J. Kirkpatrick, hockey.
G. F. Trimble, rugby.

Track

C. F. Burke.
D. J. McKenzie.
J. H. Russell.

Rowing

H. Skey.

Boxing

V. Loscombe.

Jr. School Rugby

Mulock Cup Champions
E. J. Calnan.
E. W. Moody.
M. B. Furber.
R. V. Weldon.
S. W. S. Hall.

Jr. School Basketball

C. W. Faber.
J. H. Ryan.
T. C. Swartman.
A. D. McKinney.

The funds of the Association have been expended in the following manner:—

Assets

Fees	$ 488.00	
Mulock Cup gate receipts	89.76	
School Assault receipts	9.57	
Balance (1923-24)	13.50	
Total		600.83

Expenditures

To "S"	$ 100.50	
" Torontonensis pictures	60.00	
" rugby	135.40	
" hockey	70.77	
" track	17.45	
" basketball	53.45	
" indoor baseball	3.50	
" swimming and water polo	18.60	
" rowing	31.00	
" soccer	95.20	
" B. W. & F.	18.13	
Total		604.00

This shows a debit balance. The main reason for this is due to the fact that as the registration, *i.e.*, fees, decrease, the cost of outfitting the teams remains constant. This year the executive has made every effort to be as economical as possible but until the fee is raised it is impossible to outfit all teams in an efficient manner and give suitable memoirs to championship teams and to men breaking interfaculty records. It is hoped, therefore, that the request for an increase in the athletic fee to $2.00 will be cheerfully responded to.

To the new executive the old wishes all success. It is well guided by Charlie Morrison, who has acted on the executive for the three past years. Who could want more?

And last but not least, the executive tender their greatest appreciation to all managers, especially those of rugby, hockey, and basketball, for the help they have freely given.

A. W. Jeckell,
President S.P.S. A.A.

Rugby

SENIOR SCHOOL

The Senior School Mulock Squad started the season well, about twenty-five men turning out to the first few practices. The services of Keith Carruthers were obtained for coach and things looked rosy indeed.

We played our first game against Dents and defeated them by the score 7-0. Then the trouble started!!! The Senior Med. manager defaulted, on behalf of his team, our first game together. The morning of the day that the game was scheduled, Meds. informed us that the game was on. The scrub team that we put on the field was quite badly defeated.

Dents sprung a surprise in their return game, and won for the first time in two years. The game was played in the sandy loams of St. Mike's and our fast light backs were unable to get away, and—well, we lost!

In our last game, the return game with Meds. a good time was had by all. Meds had already won the group, and so "School" had nothing to gain—except frowns from the staff for missing another Lab. The result was that only eleven men showed up; and, well, we played five-minute periods, with the opposing managers refereeing.

Taking it all round it was not a very successful season.

The following men made up the squad: Brown, Connolly, Griffith, Grime, Hewitt, Hunter, King, Jeckell, Leitch, Lloyd, W., Lloyd, D., Little, Nugent, Pentelow, Rumble, Shaw, Switzer, Sullivan, Tribble, Wallis, Warner, McKendrick, Parker.

J. W. Pearson,
Manager

JUNIOR SCHOOL

JUNIOR SCHOOL RUGBY

Once again the Mulock Cup journeys to the Old Red School, after an absence of one year. This past season Junior School was responsible for its return. From the first group game to the final with Trinity the team went through without a defeat. The men rounded out into a well-balanced rugby team under the able tutorage of Capt. Jess Carrick during the group games, and after defeating O.A.C. on a heavy snow-covered field went into the semi-finals against Senior Meds. Two games were necessary to decide the issue, and both were played on muddy fields in drizzling rain.

Top Row—S. H. Fraser, G. B. Smith, M. B. Furber, S. W. Hall, W. M .Scarth (Mgr.), E. A. Cash, G. T. Hughes, W. D. A. Chisholm.
Middle Row—E. S. Calnan, C. A. Parkinson, J. A. Carrick (Capt.), N. Scott, E. W. Moodie.
Bottom Row—C. D. Carruthers, J. W. George, H. T. Pritchard, R. B. Rochester, L. E. Shore, R. V. Weldon.
Insets—T. S. Granton, C. A. McMartin, H. C. Smith, A. M. Wilson.

Each faculty turned out almost *en masse* to support their respective teams, and they were not disappointed, for the quality of rugby played was of the best. Both teams, traditional rivals, were confident and closely matched. The second game was the better of the two and kept the crowd on their feet from the first to the last whistle. Two overtime periods had almost gone when Parkinson kicked a deadline, followed by another inside a minute, giving Junior School the game—score 14-12. This game, although played under such adverse conditions, was the cleanest and most sportsmanlike game played in the Mulock Cup series this fall.

The game with Trinity again brought the whole School to the Stadium to support their team. Odds were against School at the start, for the crowd, considering the two hard games with Senior Meds., thought they would be outplayed, but not so. Trinity opened on the offensive and had a two-point lead at the end of the first period, but School settled down to play rugby and never was the game in danger after the second period.

To pick stars from the team is difficult. A major portion of the credit for Junior School's win must be assigned to Capt. Jess Carrick. He coached the team during practices and took his place with them on the field where he was one of the most effective men in the line. On the back line were "Parkie" Parkinson, "Earnie" Cash and Scott "Y." A large measure of the team's success was due to this trio, for when long gains were required it was only necessary to pass the old pigskin to any one of the three, or when a couple of yards were needed to move the yardsticks Calnan could always be depended on to go through the line for the required gain. Charlie McMartin played a consistent and brainy game at quarter. He brought the team through many of the most crucial moments and always had the right play ready for the right time.

In the line "Gummy" Rochester, "Steamer" Hughes, Furber and Moodie played a steady and effective game. Seldom was a kick blocked or a play broken up through them. "Jim" George played his first game against Junior Arts at middle, but was later transferred to flying wing, which position he played until the first game with Senior Meds., when a sprained ankle forced him out for the rest of the season. His absence from the team was severely felt during the remaining games. Hall came to the team late in the season, but played a most effective game at outside. He and Moodie featured their playing with spectacular flying tackles and invariably brought their men to earth.

Mention of the team without the manager would be incomplete. "Monte" Scarth, by his close personal touch with the men, kept them working like a well-oiled machine, and did much to bring about the spirit of good-fellowship that was present throughout the season.

English Rugby

For the past several years Varsity has had a team to represent her in Intercollegiate English Rugby. Each year a home and home series is played with McGill, and for the past three seasons Varsity has come out victorious.

During this past season the team defeated the Toronto English Rugby team twice and won the right to challenge the Montreal English Rugby team for the McTier Cup. Unfortunately Varsity lost out in the final game, by the small score of 9—6.

Next year Guelph expects to put a team in the Toronto league, which will mean more games for Varsity to play.

It is a source of pride to School, that on this team, as on most Varsity teams, the engineers have a good representation. In fact more than half of the team last year were from School. Included in the line-up were, H. M. S. Pentelow, A. W. Jeckell, G. R. Curry, L. H. Burpee, E. M. Little, A. C. Lee, D. T. Morris, A. R. Battye, Parlser, Russell, and several others.

Most of these men are graduating this year and if School is to be properly represented on the team next year, there will have to be strong support from every man who is interested.

L. H. Burpee.

Hockey

The Interfaculty Hockey Season of 1925 was one of the most remarkable and at the same time one of the best in the history of the series. The best thing about it as far as the Engineers were concerned, was the fact that its close found the Jenning's Cup back in its original home in the Old Red School after an absence of many a long year.

Before the season opened, School was not even considered among the possible contenders, grouped as they were with the strong Med. team, champions of 1924. To the surprise of everyone, however, the end of the regular season found the ancient rivals deadlocked, and the play-off resulted in an overtime victory for School by a score of 3—2. Victoria next provided the opposition, and carried S.P.S. through two extra periods before admitting defeat.

The semi-final was played at the Arena, and on the big ice School exhibited too much speed for the Forestry sextette, earning the decision by a score of 5—0. The final found two of the greatest

teams ever turned out by the Interfaculty Series, pitted against each other. Junior Dents, fast, light, and clever; Senior School, under the tutelage of Fred Evans had developed a fast systematic attack and possessed an advantage in weight. After sixty minutes of first-class hockey, the Engineers skated off, with a well earned victory to their credit. The score was 3—1.

The team was built around three men; Little in goal, Strickland, captain and defence, and White, the leading scorer and most outstanding player in the league at right wing, but the rest were not far behind them in ability. Auld teamed up well with Strickland, and shone most where the going was the heaviest. Sutton and Connolly on the forward line were mainly noted for their back-checking, though their unselfishness on the attack greatly contributed to White's scoring average. Johnson and Little, the subs, could fill in without weakening the team, while Wallis, Tuck, Dillane and Parker, who completed the squad, not only gave the regulars splendid opposition in practice, but acquitted themselves well when given an opportunity in a regular game.

As Interfaculty Champions, School passed on to faster company, representing U. of T. in the Intermediate Intercollegiate, under the name of Varsity 2nd. Connolly and Johnson were ineligible for this series, and were replaced by Lively and Toskey, the two Med. stars. McMaster were the first opponents to be faced, and won the opening game by a score of 4—1. In the second, however, Varsity seconds tied up the round, and won out in overtime by a score of 6—5. The final was played at Kingston against McGill, and notwithstanding their lack of experience, Varsity put up a mighty battle and were only beaten by a score of 2—1. Hewitt of Junior Dents played goal in this game, Little being laid up with a sprained ankle, and it must be said in justice to him and to the two Med. stars that they worked even harder alongside of their late opponents than when pitted against them.

With White, Strickland, Little Johnson, and Lillie graduating, the outlook for next year does not look bright. Auld, Connolly and Sutton, however, remain, and with these as a nucleus School is assured of a team which, imbued with the same fighting spirit that carried this year's squad to a championship, should prove worthy successors to the greatest team that has ever represented S.P.S.

John Roper, Manager.

Association Football

During the past year football around the University has been steadily rising to its proper place in athletics. In the intercollegiate series, McGill, after an absence of several years, entered and won the honours. The Intercollegiate Union next year promises to be at full strength, with McGill, R.M.C. and Varsity entering teams. It was hoped that Queen's would be back but indications are not very bright.

The Varsity team this year was defeated by R.M.C. on the latter's grounds by the score 4-3 in 20 minutes overtime, and they in turn were defeated by McGill. The Varsity team also made a short tour of the States playing Penn. State and Swarthmore, losing to Penn. State 1-0 and playing a scoreless tie at Swarthmore. Both games were keenly contested, good soccer and good spirit being displayed. School was represented on the Varsity team by D. Melick, but next year School promises a greater representation.

In the interfaculty series the teams were greatly handicapped by lack of grounds for practice purposes, due to the resodding of the back campus. In spite of the lack of practice, the brand of soccer played by the teams was of a high calibre. Junior School's hopes of winning their group were lost due to their inexperience, Victoria winning the group honours. However, the Juniors showed good fighting spirit and are sure to be heard of in the future. Senior School suffered a great deal from lack of practise but displayed good form in the later games. Knox won the group title after several hard fought games.

In the semi-finals O.A.C. defeated Victoria in home and home games but Dents and Knox set a record for the games, six games being played before Dents finally were declared winners. In the final play-off O.A.C. defeated Dents in home and home games and keep the Arts Faculty cup for another year.

Next year School promises to be back again in the race for the cup which O.A.C. has now held for three years. The seniors lose several good players with the graduation of 2T5, but the ones coming up from the junior ranks promise to fill the gaps.

The team this year was coached by Prof. Allcut, who several times came out to coach the team at morning practices. The effect of his coaching was shown to a marked degree in the last few games played.

The following are the players who comprised the teams during the past season:—

2T5—Perry (S), M. Milne (S), F. Milne (S), Ryan (S), Bridge (S), Melick (S), Frampton (S), MacEwen and Dunbar.

2T6—Armour (S), Legge (S), Cade, Yuill and Morrison.

2T7—De Laplante, Roberts, Shields, Burnside, Barnes, Clark, Boles, Grass, Hillier, Hunter and Sievert.

2T8—Magnan and Smith.

(S) denotes players who have been awarded colours for soccer.

T. A. LEGGE, *Manager.*

Track

For another year School has held the Interfaculty Track Championship, making the sixth consecutive year.

The new trophy put up this year was the Langford Rowell Memorial Cup, given by the Victoria College Athletic Association.

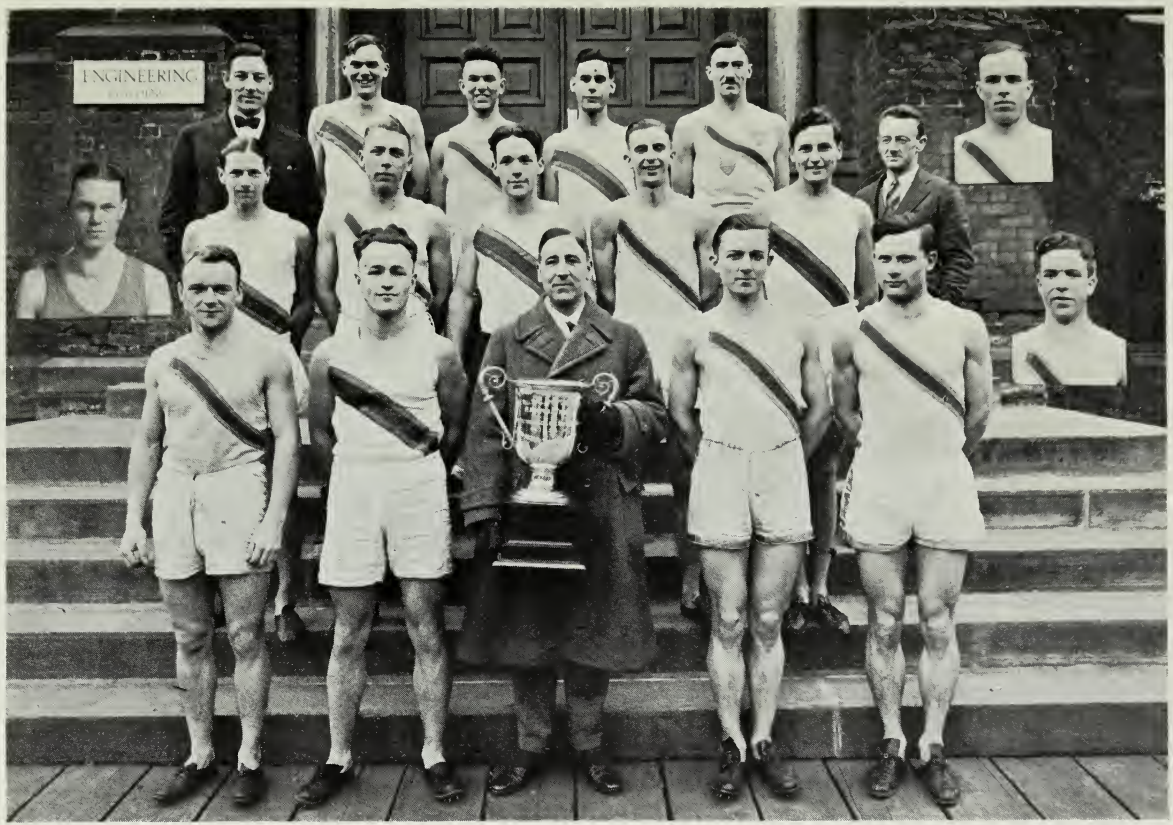
This success was made possible by the fact that large numbers of School men are interested in Track work and took part in the competitions. This is evidenced by the fact that about 70 men took part in the various events comprising the Interyear meet, where 2T8 proved the winning year, with 2T5 second.

In the Interfaculty Meet the School entry numbered 31 out of a total of 92 contestants. Of these 16 won points and thus made a place on the School team. The individual championship was a tie between D. J. MacKenzie and C. F. Burke, each of whom obtained 9 points. The grand total of 71 points out of a possible 144 was School's score, with Meds the closest team, making 27.

Following last year's custom a School Track jersey was presented to each of the new men on the team.

The following men were picked for the Intercollegiate Meet at Queen's: McKenzie, Burk, Polack ,Morrison, Pollock, Turnbull, Millican, Turner, Thompson and Perry.

In the Indoor Meet held weekly on the Hart House track School ably defended the championship held for the four years that this Meet has been held. The Toronto Cricket Club Cup was the trophy won at this Meet and we hope that it will stay in the Old Red School House. As usual, the score showed S.P.S. well ahead of the other teams, scoring 85 points out of 127. The team was composed of 14 men, two of whom broke records in the Meet. Pollock lowered McAuliffe's mile time from 4 mins., 50 secs., to 4 mins.,



Top Row: K. L. Carruthers (Coach), D. J. McKenzie, H. P. Ruggles, D. L. Polack, W. L. Thompson.
Centre Row: A. M. Grant, C. A. Morrison (Manager), C. F. Burk, A. A. Somerville, C. A. Pollock, M. G. Evans (Coach).
Bottom Row: E. F. Connolly, J. H. Russell, Prof. E. A. Allcut (Hon. President), A. D. Turnbull, S. W. Perry (President).
Insets: W. I. Turner, J. F. Millican (Hon. Vice-President), J. H. Ryan.

39 secs., and Cade's ½-mile from 2 mins., 14 secs., to 2 mins., 5 secs. Perry also clipped 1/5 second from his former 220 yard record, making it 24 seconds.

Other Meets were participated in during the year, namely, the Ontario Indoor Championships at Hamilton, the Indoor Meet at the Coliseum, and the Y.M.C.A. Indoor Championships at Central Y.M.C.A. In all these S.P.S. took a prominent place on the Varsity team.

Track men granted S's this year were: Burk, McKenzie, Russell, and Vercoe.

In closing my best wish for the S.P.S. Track Club is that it may receive the hearty co-operation and the interest of School men in all its activities. With such men as Russell, Mackenzie, Pollock and Morrison to fill the places of those who are leaving, the prospects for a successful future are rosy indeed.

S. W. Perry.

The Boxing, Wrestling and Fencing Club

The activities of School's B.W. & F. Club this year have been, in the main, the development of new and promising material. The graduation of McGuire, Seabourne, Relyea and their associates left School with no first string men of outstanding ability to carry our colours into the fistic arena, so it has fallen to the class of 2T5 to set some kind of example and stimulate the younger generation to prowess on the mat and in the ring.

As if the duties of President of the Athletic Association were not enough to keep two ordinary men occupied, Al. Jeckell stepped out in front and once again attached himself to the Intercollegiate belt. He was in top form this year and had no trouble disposing of the best Queens and McGill had to offer. He was mainly responsible for the development of the only other School man on the Intercollegiate team, A. C. Lee, who showed that he has a rosy path ahead of him, although he had the misfortune, after winning the School, Junior and Senior Assaults, to have his collar-bone broken in the Intercollegiate finals. It was tough luck, but having two more years, A. C. will have the 135 lb. Wrestling belt tucked away for us yet.

Ted Hubbard had the hardest luck of all. After endeavouring to make his usual 118 lb. this year and finding it extremely difficult,

he resigned himself to the step to the heavier class; but, feeling in top form, he ran off some of this weight at the last moment for the Senior, found he couldn't make it, and then had to fight 126 lb. class in a weakened condition. Graham of Arts had the good fortune to be handed the decision over him, and a very close decision it was. Ted has the consolation of having won the Intercollegiate 118 lb. last year.

Stevens, Toye and Lloyd were at the game on and off this year, and while they did not reach the top rung of the ladder, they helped keep School on the map. Art Toye tried Hub's game of taking off weight and while he made 126 lb. for the Senior he was put out.

The School Assault was a decided success this year and the multitude of entries shows that School is not wanting in boxing enthusiasm. Second year won the cup with third year close on their heels, first year, third and fourth year bringing up the rear, probably because so many of the latter were ineligible owing to previous wins in junior and senior company. The results of the finals were as follows:

Boxing

112lb.	Sankey,	2nd year
118lb.	Grant,	3rd "
125lb.	Hayward,	2nd "
135lb.	Wolfe,	1st "
147lb.	Loscombe,	1st "
158lb.	Ramsey,	3rd "
175lb.	McKenzie,	1st "
Heavy Weight—	Ruggles,	2nd "

Wrestling

118lb.	Irwin,	2nd year
135lb.	Lee,	2nd "
147lb.	Bailey,	3rd "
158lb.	Delaplante,	2nd "
175lb.	Anderson,	3rd "
Heavy Weight—	Millican,	4th "

Fencing

Dyment, 1st year

The medals for the winners were presented by the Dean at the last meeting of the Engineering Society in December, on which occasion he complimented the following men on their success in the Junior Interfaculty Assault:

Lee.....135lb. Wrestling
Howard.....135lb. Boxing
Loscombe.....147lb. Boxing
Robertson.....112lb. Boxing

Dyment won the finals in Fencing though outpointed in the preliminaries, and showed excellent form.

Loscombe gives promise of being remarkably well able to fill the vacancy left on the Intercollegiate team by Martin, and if he improves at the rate he has this year, will doubtless be an Intercollegiate champion before his sojourn here is ended.

Howard is another two-fisted mitt artist, who should go far if he sticks at it.

School won the Junior Interfaculty Assault by the small margin of five points, and it is too bad that lack of experienced men prevented the acquisition of the Davidson Cup.

The graduating members of the B. W. & F. Club Executive take this opportunity of thanking the men of the lower years who have so ably assisted them in the attempt to improve the team and wish them every success in the Davidson Cup run next year.

D. S. Lloyd,
Mgr.

Rowing

School is in the top rank of the rowing game for good by the appearance of its past record. This year, with the resumption of interfaculty competition, we captured the interfaculty championship, entering two crews on account of the quantity and quality of material which turned out. There is very little time available to train men in the science of rowing, and it was coaching of a very rough order that was used. But after a week on the machines and a few days on the water it certainly looked as if School had a very fair chance of winning again as we did in 1921. Training was very irregular on account of trips of the M. and E. Club, but the men were conscientious enough to go down on those chilly mornings at six-thirty, and that kind of spirit is bound to win.

As luck would have it the two School crews were drawn against each other. The only consolation was that we were sure of an entry in the finals. Crew No. II rowed the whole race with a broken seat and even then finished only a length and a half behind Crew No. 1. They were all green men except stroke and seven, and deserve a great deal of credit for such a game exhibition. Crew No. 1 had two experienced men in stroke and seven and also had men who had been in a work-boat before.

In the semi-finals our crew defeated Arts II crew by about five lengths and immediately had to set out to row Arts I, who had beaten Victoria in the previous race. Both crews got away to a very fine start with School slightly in the lead. U. C. used a shorter

Rochester (Stroke), Fisher, Clark, Heron, Shaw, Ruggle, Shey, Douglas (Bow)
Smart (Cox)

faster stroke which proved their undoing. The long, steady pull of the School crew kept them in the lead all the way and although Arts challenged with a wonderful sprint when about a quarter to go, School's lead and staying power kept them two and a half lengths to the good at the finish.

This is School's second victory in rowing and should be the start of another field of sport of the finest quality for Science men to take part in.

The personnel of the crews was as follows:

Crew I—Rochester, Fisher, Clark, Heron, Shaw, Ruggles, Skey, Douglas.

Crew II—McQueen, Seibert, Lilly, Jackson, Anderson, Campbell, Boehm, Griffith.

GEORGE SMART,
President.

Swimming and Water Polo

School has been a little unfortunate in the last two years as regards to swimming. With the graduation of 2T3 we lost the nucleus of the swimming team. By the time 2T4 passed out, so did most of the swimmers. Thus School was forced to compete for the Fitzgerald Cup (Interfaculty swimming trophy) with a new, inexperienced team. Everybody performed creditably, considering they were opposed to the best swimmers in the University.

Chorolsky distinguished himself again by breaking his own Interfaculty record for the 100 yard breast stroke. He also represented the Varsity swimming team in this event in competition against McGill University. Shortreed, the School long plunger, also on the Varsity team, made Vernot of McGill break the Canadian record for the long plunge in order to obtain the verdict.

The following fish also took part in aquatic activities: S. M. Jones, W. Enouy, C. Booth, A. J. Hill, E. Chorolsky, I. Lorenzen, and J. Shortreed.

The men remaining should form a good swimming team next year, and with the addition of new members are bound to go a long way in the next Interfaculty Swimming Meet.

A. J. Hill, Manager.

Basketball

In keeping with the efforts of all teams to bring honours to School in Interfaculty competition, School's two basketball teams had eyes on the Sifton Cup right from the beginning of the series.

The record of each team is unique. Both won in their respective groups without a defeat. Each won in the semi-finals, although Sr. School had to play three games against Wycliffe to decide the issue—and both teams met in the finals—which has seldom happened in any sport.

The final game was played March 27th, and the result showed that the aggressiveness of the Juniors was no match for the Seniors' experience; and for the first time in the history of the Sifton Cup Sr. School were declared winners. The team was composed of the following: Forwards, D. W. Dow (Capt.), W. I. Turner, E. G. Davies, D. J. McLean, E. M. Little, L. Grime; defence, W. O. Sorby, T. H. Patterson, C. A. Armour.

F. J. Milne, Manager Sr. School.

Indoor Baseball Club

Due to the lack of starting ability in the baseball line School have now to content themselves with seeing the 1925-26 session ushered in before they can hope to have the Spadling Cup rest in the "Little Red Schoolhouse".

The faculty grouping of teams this year affected School as follows:—Group I. Jr. Arts, Victoria and Jr. School; Group 2. Sr. Arts, St. Michael's, Dents and Sr. School.

In their group Jr. School, ably managed by Gord. Holden, put up great opposition to Arts and Vic, Vic finally winning the group, to be later eliminated in the play-offs by Jr. Meds. Jr. School lined up as follows:—Burns, G. Smith, Edmonson, Holden, Somerville, Hanks, Hillier, Irwin, J. George and Skey.

Senior School were a little more fortunate in their group, but fell one short of realizing their ambition of eliminating Dents. Sr. School finished next to Dents, the 9—5 and 7—6 defeat to the tooth-pullers marring their otherwise clean sheet. School were unfortunate in that their crucial games came at a time when Little, the regular moundsman was laid up with a badly sprained ankle.

Turner substituting, however, turned in three nice exhibitions, his only loss being a 7—6 defeat to Dents.

The Seniors lined-up several "old-timers" who were regulars from their first year. Here's the team:—Little, Lloyd, Turner, Teagle, Morrison, Dillane, Hill, Menzies, Limage, Inglis, Legge, Auld.

At the time of writing O.A.C. have eliminated Dents in the play-offs and Jr. Meds have disposed of Vic, so that in the coming week Jr. Meds and O.A.C. meet in the finals.

Next year I hope that the managers of the respective Junior and Senior teams will be appointed earlier, so that there will be time for the necessary work of rounding up men and arranging a little serious practice. This is all that is necessary for the reception of Mr. Spadling's Cup, as A-1 baseball material is at hand.

Best of luck for 1925-26.

W. G. Lloyd, Manager Sr. School.

Tennis

Before reviewing the past year's activities in tennis, I would like to say a few words about the game itself.

As far as I have been able to ascertain, lawn tennis is essentially a modern pastime, its origin dating back about fifty years ago. Its genealogy is rather obscure, but like all other games, that it had antecedents there can be no doubt or question.

The first of these is said to be a game known as "lusco pelaris" to the ancient Romans, and in which a ball was struck or tossed from one point to another for sport.

In Europe, we find it appearing and developing into court tennis in the Middle Ages, being the sport of royalty only, though later the property of the masses.

In Italy it was known of as "guioco della polla" and in France as "jeu de paume".

Enclosed courts were then built and the outdoor game was then known as "la longue paume" in France, and "pallone" in Italy.

One author claims that the French outdoor game is the most direct antecedent of our game. It was played wtih a cork ball struck, either with the bare hand or in some cases a gloved hand, over a mound of earth about two feet high. Later crude wooden rackets were devised with gut strings and in this form the game

was introduced into England, and a record of "field tennis" about the eighteenth century, speaks of it as a dangerous rival of cricket.

In the French game the server cried "tenez", and it has been suggested that the English have preserved the phonetic sound of the word and called the game tennis.

Apparently Major Walter C. Wingfield, a British army officer, invented lawn tennis as known to us, as he patruled it in 1874. He called it "sphairistike" or "play ball". It was played on a court shaped like an hour-glass, sixty feet in length and thirty feet in width at the base line and converging to a centre net twenty-one feet wide. The net itself was seven feet high at the ends and four feet eight inches at the centre. The method of racket scoring was used and service was played from a space in the middle of the court.

These dimensions were later changed and in 1875 the length, as used to-day was set by the Marylebone Cricket Club, and in 1877 there was held the first all-England championship meet. Just before the meet the court was made rectangular and later in about 1882 we have the scoring and court dimensions of the present day.

From 1877 on tennis has developed steadily, new strokes being formulated and receiving prominence at particular periods, but they have not necessitated any major change in the game. However, the game of to-day requires a great deal of skill and is unquestionably a sport that is second to none in its all-round development of the body.

Last year we had a large entry list in the Interfaculty Meet and made a very creditable showing, but owing to the lack of funds we were unable to hold the faculty championship meeting as instituted in the academic year of 1923-24.

The time at which tennis is played, of course, has a tendency to keep the game in the realm of minor sports, but as soon as the authorities realize the real value of the game, it certainly is worthy of as much recognition as rugby, if you don't look at our institution as a commercial enterprise seeking profitable returns, better facilities for developing the game will be provided.

With these thoughts in mind, I would suggest that our own Faculty take some initiative and provide next year in their budget for the maintenance of a championship tournament.

C. A. Armour.

"T" Holders

Front Row—
E. B. Hubbard (Boxing),
G. W. Smart (Rowing),
W. O. Sorby (Rugby),
F. A. Sievert (Rowing),
A. D. Turnbull (Harrier).

Second Row—
K. A. Kirn (Gym),
R. A. Fisher (Rowing),
E. Chorlosky (Gym),
H. Vernon (Rowing),
S. W. Perry (Track).

Third Row—
W. G. Lloyd (Rowing),
N. G. Scott (Rowing),
C. A. Pollock (Rowing),
C. A. Morrison (Track),
H. M. S. Pentelow (Br. Rugby).

Fourth Row—
W. L. Thompson (Rowing),
W. S. Kirkpatrick (Rugby),
W. I. Turner (Track & Rowing),
F. J. Millican (Track).

Inset—
Left, A. W. Jeckell (Wrestling),
Right, Prof. T. R. Loudon (Hon. Pres. S.P.S. Ath. Assoc.).

Billiards

This is a game which seems to have a natural appeal for School men. Properly played there are few more scientific and skill-requiring games.

The Billiard Room with its excellent equipment is familiar to all. There are at present two small billiard tables and one pool table. The remainder of the room is occupied by large standard size tables, six in all.

The "Major", or Staff-Sgt., H. H. Roberts, Royal Grenadiers, is known to all. He is a crack rifle shot. In 1910 he won the Championship of Canada and has been on the Bisley team many times.

School has done well in Billiards this year. W. T. Burns won first prize in the Open Billiard Tournament last Fall, defeating the best players of the University in even competition, G. H. V. Belyea won second prize. W. T. Burns won second prize in the Snooker Tournament, and W. H. McCullough third prize.

G. H. V. Belyea won first prize in the Ladder Handicap Tournament, and W. T. Burns won second prize. This tournament extended for 10 weeks, from the middle of January to the 21st of March. It was a real test of Billiard ability.

The final results of the Handicap Elimination Tournament are not yet available. The winner holds the championship of the University for one year, has his name inscribed on the trophy in the trophy case, Hart House, and receives a sterling silver replica. The runner-up also receives a cup. School is represented in this tournament by P. Wigle, who plays J. C. Jack of U.C., in the semi-final. The winner plays N. R. McConkey in the final.

An exhibition match was held in the big gym Tuesday, March 3rd, between Stevenson, former World's Champion, and Cook, the Ontario Champion. Stevenson spotted Cook 300 points and won 800— .

The success of this exhibition was largely due to the efforts of "Jack" McNiven, 2T2 School Grad. member, who was in charge of the sub-committee, ably assisted by A. E. Beaman, 2T5, and C. H. Riches, 2T7.

The aim of the committee has always been to encourage the playing of English Billiards, and to try to provide the best equipment and operation of the room possible. Any complaints or suggestions are gladly received.

J. D. Burbank, 2T5, Secretary Billiard Committee.

U. of T. Rifle Association

Another successful year for the University of Toronto Rifle Association is nearing a close.

The Association dates back to 1904. During the war all Canadian Civil Rifle organizations were inactive, and it was therefore not until 1920 that reorganization began.

Outdoor shooting commenced at Long Branch in October and lasted until the early part of November. All shooting was done at the ranges of 200, 500 and 600 yards, the .303 Lee-Enfield rifle being used. These rifles, as well as ammunition and all other requirements, were supplied us by the Dominion Government.

The success of this year's outdoor rifle competitions was largely due to the interest that Major Ulton, from the Militia Department here, took in the Association. In the outdoor Canadian Inter-Collegiate rifle competition of 1924 the Varsity team, on which were three School men, ranked third, five teams in all having competed. A fine silver medal was given to each of the eight men who made the team. For the first time since the war the University of Toronto Rifle Association competed in the Imperial Universities' Rifle Match held on October 31, 1924. S.P.S. was again represented by three members on this team. Weather conditions during the match were very unfavourable. The Secretary has received no word of the team's standing on the writing of this report.

Dents won the outdoor Inter-Faculty match and with it the DeLury Shield, which last year was held by School. Professor DeLury is donating pins to each member on the winning Inter-Faculty team.

The Association is the proud possessor of the Hart House Indoor Rifle Ranges, which are the finest of its kind, as outdoors the .303 Lee-Enfield Rifle is used with gallery practice ammunition. This indoor range offers to many students, and especially to School men who cannot spare the time to go to Long Branch in the Fall, a real opportunity to perfect their marksmanship. Facilities are even better this year than ever through the untiring efforts of Captain T. E. Hayhurst, who installed a new lighting system in the ranges.

School have 37 out of 125 members on this year's Rifle Association, which is an increase of two over that of last year.

Shooting on the Indoor Ranges started the latter part of November. Varsity won the first Inter-Collegiate indoor match, being two points up on R.M.C. with two more matches which have yet to be shot.

Keener interest should be taken next year in Inter-Faculty indoor shooting owing to the fact that Dean Mitchell has promised a fine cup for annual competition.

RESULTS OF CANADIAN INTER-UNIVERSITY OUTDOOR RIFLE MATCH

Queen's University R.A.	734
University of McGill C.O.T.C.	716
University of Toronto Rifle Association	688
University of Manitoba C.O.T.C.	667
University of Alberta C.O.T.C.	637

A. A. SOMERVILLE, Sec.-Treas.,
U. of T. R.A.

Chess

The chief officers of the U. of T. Chess Club for the session 1924-25 are as follows: Honorary President, Principal M. Hutton; Acting President, W. H. Coulter, S.P.S. IV; Secretary-Treasurer, L. J. Harris, Arts III; Graduates' Representative, C. E. H. Freeman; Staff Representative, Dr. R. D. Rudolf; S. P.S. Representative, J. D. Burbank, S.P.S. IV; Team Captain, J. P. Dandy, B.A.

The "raison d'etre" of the Chess Club in the University is to provide a source of entertainment for those students who like to exercise their mental skill along mathematical lines or to give expression to their genius in some tangible form. The Club also serves as a school for the instruction of less fortunate men who desire to become acquainted with at least the general principles of the game, and who require a more or less intimate contact with more experienced players in order to accomplish this end. The Club also fulfils an important duty in bringing the staff, graduates, and undergraduates closer together, and to give the occasional student a chance, perhaps, to even up the score with one of his Professors in more favourable surroundings than the lecture room.

This year a new development has occurred in the club, *i.e.*, the inter-university matches. Such matches bring the different universities into closer contact, and understanding with each other, in a much different way than is done by rugby and hockey matches, or other sport or athletics. The reason for this is the type of man who constitutes the team. A chess player is naturally a deep thinker, and the exchange of ideas occurring at such functions is along different lines than those at athletic meets, etc.

Chess received a rather severe set-back in Toronto this year

due to some misunderstanding in the formation of the City Chess League, as this worthy body failed to materialize. Due to this a great deal of interest usually shown to the game was lost, and it seems that no other substitute, *i.e.*, impromptu matches with other clubs, or amongst the members of our own club, fills the gap or gives rise to the same degree of enthusiasm.

A type of chess which was unusually popular this season, (probably due to the absence of any league games) was in the shape of simultaneous games. Both Mr. Morrison, the Dominion champion, and Mr. Gale, ex-Dominion champion, gave exhibitions at the Club, and some very interesting chess was developed at these matches.

The Theosophical Society again challenged us to a friendly match, which resulted, fortunately, the same as last year.

Probably the most important events of the season were the two inter-university matches, with the University of Pennsylvania, and the University of Buffalo. These matches were held at Buffalo the first week in February. Although our team was successful against Buffalo, matters did not shape so well against Pennsylvania, and we were enabled to extract only one victory of the four games played with them. Further university matches are expected to develop next year, and it is hoped a little more publicity will be devoted to them.

An undergraduates' open tournament is run every year, with prizes to the winner, runner-up and best novice. This tournament is always a success, and brings out the relative merits of the members, as no other function could possibly do.

It might be well to point out the rather unpleasant fact that the ratio of School men to Arts is considerably lower this year than last. It is generally considered that at least a plurality, if not a majority of the members, should be School men. It is hoped this little reminder will scare up a substantial quantity of School talent for next year, as its presence in the club is necessary to prove that School still excels in all sports—physical or mental—outdoor or indoor.

W. H. Coulter, President.

THE ENGINEERING SOCIETY

University of Toronto

TRADING ACCOUNT

For Period ending February 28, 1925

Sales		$9,246.22
Mdse. Inventory, April 1, 1924	$3,200.00	
Mdse. Purchases	7,232.26	
	10,432.26	
Less Inventory, Feb. 28, 1925	3,210.93	
	7,221.33	
Add Salaries	615.00	
	7,836.33	
Gross Profit to Profit and Loss	1,409.89	
	$9,246.22	$9,246.22

PROFIT AND LOSS ACCOUNT

Publications	$ 94.80
General Expense	427.87
Loss on Dinners	44.77
Loss on Dance	156.12
Grants	29.00
	$ 752.56
Balance Carried Forward	770.07
	$1,522.63
To Surplus Account	1,746.07
	$1,746.07
Gross Profit from Trading Account	$1,409.89
By Interest and Discount	100.67
Stunt Night	12.07
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Balance Brought Forward	770.07
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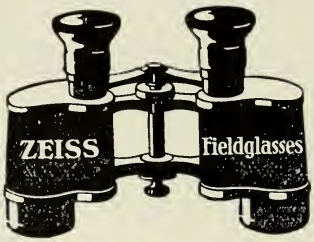

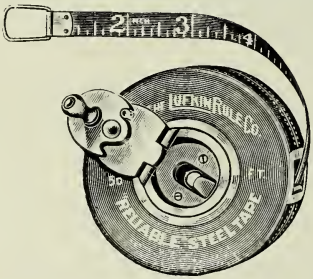

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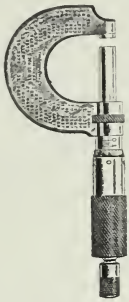

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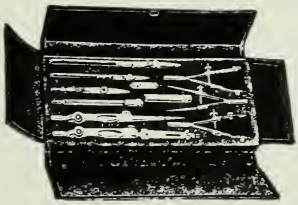

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